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U.S. Environmental Protection Agency
Superfund Program – Region 2

Bridgeport Rental and Oil Services (BROS)
Logan Township
Gloucester County, New Jersey
Proposed Plan

INTRODUCTION

This Proposed Plan identifies the *Preferred Alternative* for cleanup of groundwater, soil and sediment contamination at the Bridgeport Rental and Oil Services (BROS) Superfund site, and provides the rationale for this preference. The proposed remedial actions are categorized as Groundwater Work and Wetlands Work. The actions contemplated under this Proposed Plan are designated as Operable Unit (OU) 2 work.

The Groundwater Work has been further divided into two major sub-categories to address media or area-specific concerns. The sub-categories are *Soils, Light Non-Aqueous Phase Liquids (LNAPLs), Shallow Groundwater,* and *Deep Groundwater*.

The Groundwater Work includes addressing on-property and off-property shallow and deep groundwater contamination associated with drinking water aquifers (water bearing strata) of the Potomac-Raritan-Magothy (PRM) system. It also includes components designed to address residual subsurface soil and LNAPL contamination which impact the groundwater system and are themselves media which represent potential exposure points in the human health risk model. For example, the contaminated soils and LNAPL are a potential exposure point/source to construction workers through a direct contact pathway and future building occupants through the vapor intrusion pathway.

The PRM aquifers were impacted by releases from on-site sources including the former 13-acre waste oil lagoon, tank farms, contaminated debris, residually contaminated soil and LNAPLs. The former waste oil lagoon and tank farms were cleaned up as part of the OU-1 remedy for the site. The OU-1 actions were completed in 1997.

The Wetlands Work includes addressing the stream corridor and wetland areas both on-property and off-property. The wetland areas were impacted by the releases of contaminants from the former waste oil lagoon during a series of overflow/spill events in the late 1960's and 1970's.

Preferred Alternative

The *Preferred Alternative* is a set of alternatives which combines technologies, within an adaptive management approach, to address both impacted media as well as post-lagoon remediation residual contamination. The preferred alternative, which is described in greater detail in the Preferred Alternative section of this Proposed Plan, includes the following Groundwater and Wetlands Work activities:

- Soil "Hot Spot" management through cover and drainage improvements, improved water budget management (using phytoremediation techniques), enhanced biodegradation, and institutional controls (ICs);
- LNAPLs management through cover and drainage improvements, limited property excavation, improved water budget management, enhanced LNAPL recovery via bioslurping with steam injection, where warranted, and ICs;
- Shallow Groundwater management through residual source remediation controls, improved water budget management (using phytoremediation techniques), groundwater extraction concurrent with the LNAPL removal system, monitored natural attenuation and ICs;
- Deep Groundwater management via in-situ chemical oxidation treatment and enhanced biodegradation in conjunction with source area pumping and treatment (with a contingency for hydraulic containment – see below for additional information); and,
- Wetlands sediment excavation, ex-situ treatment, off-site disposal (via landfilling),

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in-situ treatment with sorptive agents, backfilling and wetland restoration for the more highly contaminated areas, and monitored natural remediation with institutional controls for the less contaminated areas.

Institutional controls will include incorporating the following into the remedial decision for the site:

- Existing on-property deed restrictions already recorded with the township;
- State of New Jersey groundwater use restrictions (i.e., the Classification Exception Area/Well Restriction Area designation for site-specific areas); and,
- Controls for vapor intrusion (future use).

Future consideration of the purchase of real property, for remediation areas which do not meet proposed cleanup levels, may also be appropriate.

As noted above, certain restrictive covenants or use provisions for the BROS property have already been established to assist in the management of on-property risks. The restrictions stipulate the following: (1) the premises shall never be used for residential purposes or for the conduct of any retail business; (2) while commercial and industrial purposes are allowed, the site shall not be used for schools, camps or day care purposes; and, (3) all subsurface activities on the premises are prohibited without prior written approval of EPA and the New Jersey Department of Environmental Protection (NJDEP), and the installation or use of wells on the premises is prohibited without prior written approval of EPA and NJDEP.

Groundwater Work Contingency

The Groundwater Work adaptive management approach includes discrete remedial actions and a "Contingency" action. The contingency action includes deep groundwater hydraulic containment pumping in place of in-situ groundwater chemical and biological treatment. The contingency action will only be implemented if the primary technology for cleanup of the deep groundwater media fails to achieve the established remedial goals. Also, implementation of the steam injection component of the preferred remedy (designed to mobilize highly viscous LNAPL) will be dependant on the success of the bioslurping effort.

Completed Remediation/Risk Reduction Activities

Previous cleanup activities performed by EPA reduced the source material present at the site, thereby reducing the associated human health and ecological risks. These actions included: excavation and on-site incineration and off-site disposal of waste materials from the former waste oil lagoon; excavation and disposal of additional volumes of non-hazardous soil, drums and water from two drum pit areas east of the former waste oil lagoon; and the recovery and off-site disposal of over 11,000 gallons of contaminated waste oil which was floating on the water table on the BROS property. The dismantling of the former tank farm and installation of an alternative water supply for nearby residents were also completed during the OU-1 remedial phase.

More recently, to further reduce site risks, in conjunction with the local water purveyor and township, public water service was provided to homes just outside the footprint of the groundwater plume emanating from the site. Also, EPA dismantled and disposed of the hardware and structures from the wastewater treatment plant utilized during OU-1 actions.

Groundwater/Wetland Work Objectives

The primary objective for the OU-2 Groundwater Work remedial action is to restore contaminated shallow and deep groundwater in the Upper Potomac-Raritan-Magothy (PRM) and Upper Middle PRM formations to their classified and beneficial use as drinking water aquifers. However, despite extensive remedial actions performed to date, along with those proposed in this plan, there remains a substantial quantity of subsurface residual contamination which may be difficult or even impractical to completely clean up. Therefore, while remedial actions are expected to attain applicable or relevant and appropriate standards (ARARs) in off-property areas, the feasibility of meeting ARARs on the BROS property itself is uncertain. (The Remedial Action Objectives section of this Proposed Plan provides additional information on this subject.) Although an ARAR technical impracticability waiver is not being proposed for the on-property area at this time, it may be considered at some point in the future – but only after EPA determines that all reasonable efforts to achieve the remedial goals have been made.

A second main objective is eliminating LNAPL (with a focus on the more mobile free phase LNAPL) and reducing soil contaminant levels on-property to below industrial (non-residential) cleanup guidelines developed by the State of New Jersey.

Likewise, for the Wetland Work remediation effort, despite the implementation of the significant sediment removal and wetland restoration endeavor outlined in the Preferred Alternative section of this Proposed Plan, some low-level residual sediment contamination may remain at the surface and in the subsurface. Fortunately, these low residual levels do not cause human health risks in the wetland to exceed threshold values, and a detailed quantification of ecological risk indicated that areas outside the proposed active remediation zone do not pose a risk above threshold levels to relevant ecological receptors. In addition, wetland residual wastes are immobile for the most part, and it has been determined that performing highly disruptive active remediation in those areas would create a more adverse condition than leaving the lower levels of residual contamination in place. In response to leaving some low-level contamination in the wetland, a monitoring program will be instituted to address the potential for future ecological risk associated with this contamination.

Based on information obtained during the remedial investigation and a careful analysis of all remedial alternatives, EPA believes that the Preferred Alternative will achieve the objective of protection of human health and the environment, while minimizing the short-term ecological risks associated with performing intrusive activities in the wetland.

SITE BASICS

Site Location

The BROS site includes both on-property and off-property areas where contamination has come to be located. The on-property area is comprised of a 30-acre parcel of land just south of Cedar Swamp Road in Logan Township, Gloucester County, New Jersey. The off-property area encompasses approximately 400 acres of upland area, open water, emergent and forested wetland surrounding the property, and a significant land mass hydrogeologically downgradient, where contaminated groundwater has come to be located. Figure 1 provides the Site Location Map.

The site's prominent feature was the 13-acre waste oil lagoon. The lagoon was excavated and backfilled with clean fill and incineration ash derived from the OU-1 remedial actions. The lagoon remediation effort was completed in 1997. The site is currently an open upland area surrounded by rural and agricultural land. A field which has been used for agricultural purposes (e.g., a peach orchard and currently for grapes) is located immediately west of the site.

Gaventa Pond, a former sand mining pit, lies immediately south of the field. Vacant land and Swindell Pond, also a former sand mining pit, are located south of the former lagoon area. Little Timber Creek (LTC) and Little Timber Creek Swamp (LTCS) are located east of the site. Cedar Swamp Road and Route 130 form the northern boundary of the site. LTC receives drainage from LTCS and flows north under Route 130 through Cedar Swamp (CS) to the Delaware River, some two miles downstream. Figure 2 provides the Site Map.

Lead Agency

This document is issued by the EPA, the lead governmental agency for site activities. The New Jersey Department of Environmental Protection is the support agency. EPA and NJDEP will select a final remedy for the site after reviewing and considering all information submitted during the 30-day public comment period. EPA may modify the Preferred Alternative or select another response action based on new information or public comments.

EPA is issuing this Proposed Plan as part of its public participation responsibilities under Section 117(a) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and Section 300.430(f)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This Proposed Plan summarizes information which can be found in greater detail in the Remedial Investigation and Feasibility Study (RI/FS) reports and other documents contained in the Administrative Record for the site.

EPA and the State encourage the public to review the documents in the Administrative Record to gain a more comprehensive understanding of Superfund activities that have taken place at the BROS site and to review and comment on the Proposed Plan. Information on where to send comments is presented at the end of this plan.

SITE BACKGROUND

Site History

The BROS site began as a sand and gravel mining operation in the mid-to-late 1940's. Dredging from an open pit was the primary mechanism for sand recovery. The sand was mined to a depth of approximately 25 feet. During the 1950's and 1960's, the surface area of the main dredged area formed a network of lagoons which filled with groundwater and precipitation.

A waste oil storage and recovery and tank leasing operation was begun at some point during the late 1960's and continued until 1981, when a court order stopped all waste handling activities. A tank farm consisting of tanks and process vessels was constructed (also known as the production area), and at some point after the initial mining operation was discontinued, waste oils and drums were disposed in the on-site lagoon(s). Over time, the main lagoon brimmed with chemical wastes and expanded to 13 acres. At the height of the operation, the tank farm included 100 tanks and vessels.

On one occasion in the early 1970's, the waste oil lagoon overflowed, spreading contaminants into the adjacent LTCS and LTC. Approximately three acres of the LTCS were significantly impacted. This overflow event caused extensive damage to plant life. Significant quantities of volatile organic compounds and metals were found in groundwater surrounding the site as a result of leakage from the former lagoon and production area, and overflows of lagoon materials into the wetland.

In 1982 and again in 1983, EPA pumped out and treated aqueous waste from the lagoon to prevent another lagoon overflow. The site was formally added to the Superfund National Priorities List in 1983. An EPA Record of Decision (ROD) was finalized in 1984 which called for the remediation of the waste oil lagoon, removal of the tank farm, and the installation of an alternative water supply to 15 homes.

The alternate water supply work was undertaken during 1985, and the award to demolish the tank farm and dispose of the associated wastes was issued in September 1986. More than 350,000 gallons of oils, sludges and other hazardous liquids were removed during the tank farm remediation. As part of this work, an aqueous wastewater treatment system was constructed.

Efforts to address the lagoon wastes began in earnest in March 1989. After a few years of detailed investigation and evaluation, including trial burns of the lagoon waste material, remedial activities were initiated in November 1991. The lagoon cleanup involved the on-site thermal destruction (incineration) of more than 172,000 tons of hazardous wastes and the treatment of almost 200 million gallons of wastewater. The lagoon was backfilled with sand, lime-treated ash, stone and clean topsoil to grade. This work was completed by 1996.

The Phase 2 RI/FS, which was begun in 1997, was conducted with the understanding that the primary sources of contamination have to a significant degree been removed. Consequently, the mass loading of chemicals of potential concern to exposure pathways has been decreased substantially.

During the Phase 2 RI/FS field work, two areas with debris and drums were encountered along with a number of areas exhibiting the presence of LNAPLs. To address the two debris/drum areas, EPA completed a removal activity. Between September 2001 and December 2002, 350 drums, eight cylinders and approximately 4,000 cubic yards of soil were excavated and transported off-site for disposal.

EPA also conducted investigatory activities to better define the nature and extent of the LNAPL problem. Upon evaluation of the investigation data, 15 oil recovery trenches were installed as an interim measure to control the potential release of LNAPLs. Working in conjunction with the Agency's Emergency Response Team, five passive oil recovery systems were installed in 2002. The passive oil recovery system continues to operate and, to date, over 11,000 gallons of contaminated LNAPL have been recovered and shipped off-site for treatment/disposal.

The Phase 2 RI was submitted in May 2004 and their FS was submitted in November 2005. A bench-scale treatability study to determine the feasibility of chemical and biological treatment of groundwater was conducted as part of the Phase 2 RI/FS work. EPA has reviewed and approved the RI/FS reports and other documents which support the alternatives described in this Proposed Plan.

Enforcement Activities

NJDEP initiated several enforcement actions against the owners of the BROS operation during the five-year period from 1975 to 1980. In response to the enforcement actions, the property owners proposed and attempted various cleanup efforts. EPA, however, did not consider the cleanup efforts to be successful. This led to a court order prohibiting commercial waste handling activities at the site. EPA subsequently initiated response actions.

After a complex enforcement activity, a large group of federal, state and private parties agreed to work cooperatively, to pay for and conduct the investigatory and cleanup activities related to the groundwater and wetlands contamination. The agreement was detailed in A Consent Decree (CD) entered by the New Jersey Federal District Court on January 17, 1997. In accordance with the CD, under EPA oversight, the Settling Parties prepared a Phase 2 RI/FS report which was submitted to EPA for its review and approval and which describes the nature and extent of site-related contamination, establishes site cleanup goals, and identifies and provides cost information for the preliminary remedial action alternatives.

SITE CHARACTERISTICS

Site characteristics including information on the physical setting of the site, land use, and nature and extent of contamination are presented below.

The environmental investigatory activities conducted to characterize the site were quite extensive. Field sampling programs included the collection and analysis of over 140 groundwater samples, 458 wetland and pond samples, 63 fish and small mammal tissue samples, and 61 wetland and pond surface water samples. A total of 85 soil borings were installed, along with the construction of 49 new monitoring wells, 50 LNAPL delineation borings and well points, and 15 test pits. About 265 additional samples (from boreholes) were analyzed for the presence of LNAPL using dye and UV fluorescence testing protocols.

Samples were analyzed for a wide range of parameters including volatile organic, semi-volatile organic, pesticide, polychlorinated biphenyl (PCB) and metals compounds. Testing for physical and geochemical parameters such as specific gravity, viscosity and total organic carbon, and pH was also carried out. In addition to sampling activities, geophysical surveys, two major aquifer tests and groundwater simulation model runs were conducted.

Topography and Surface Water Drainage

The site is located in an area of the New Jersey coastal plain which is predominantly gently undulating plains with little topographic relief. The area is dissected by marsh and swamp areas which bound tributaries leading to the Delaware River (to the west and north). Site elevations range from near sea level to approximately 15 feet above mean sea level.

As a result of remedial actions completed at the site, the 13-acre lagoon area was backfilled with sand, lime-treated ash (i.e., soil-like material produced from the incineration of lagoon waste materials) and stone to grade. The lagoon was capped with clean finer-grained material, topsoil and grass and graded to promote drainage. Today, the on-property area is flat to gently undulating. Impacts to site drainage due to land settling in the former lagoon area are addressed by the Preferred Alternative.

Surface water drainage from the eastern portion of the site, and to which overflow from the former lagoon historically discharged, is directed to Little Timber Creek and Little Timber Creek Swamp. Swindell Pond and Gaventa Pond receive a limited amount of surface runoff from the south and west sides of the property, respectively. LTC flows through LTCS and Cedar Swamp prior to discharging to the Delaware River.

LTC is an intermittent stream south of Route 130 that does not have a defined channel east and north of the BROS property. Flow within and from LTC is highly dependent on seasonal conditions and precipitation events. Monitoring and dye flow/movement tests conducted during the RI indicated the existence of some preferential flow paths in the swamp, but the general braided nature of the area creates a generally diffuse flow pattern between Route 295 and CS. This diffuse pattern limits the flow of water from the site area.

Seasonally, there are periods when no standing water or stream flow is present in LTC/LTCS. Some interconnection between LTC/LTCS and Swindell Pond has also been documented. While Cedar Swamp is tidal, there is a tide gate which separates CS from LTC in the area of the site.

During the RI activities, both jurisdictional and non-jurisdictional wetlands were identified and mapped. At total of seven jurisdictional wetlands were identified on-site. These include the areas of

LTCS and CS which were investigated to determine impacts from past BROS releases.

Geology/Hydrogeology

The entire site overlies unconsolidated strata of the New Jersey Coastal Plain physiographic province. Regionally, the strata consist of a southeastward dipping wedge of sands, silts and clay. For the purpose of investigating and evaluating the vertical and horizontal extent of contamination in groundwater, the hydrogeologic units underlying the site have been identified. Discussion in this Proposed Plan details information on the two uppermost aquifers known as the Upper Potomac-Raritan-Magothy (UPRM) and the Upper Middle Potomac-Raritan-Magothy (UMPRM). Sampling of the next deeper aquifer, early in the investigation process, indicated that it had not been impacted by BROS constituents.

The UPRM is the water table aquifer at the site. It consists of three hydraulically connected stratigraphic units. The units range in thickness from 10 feet below the former lagoon area, to greater than 100 feet downgradient near the terminus of the deep groundwater plume. Groundwater levels in the UPRM vary seasonally, but are typically around 4 to 5 feet above mean sea level (about10 feet below the land surface) in the middle of the BROS property and within a few feet of, or at the land surface in wetland areas which border the property.

A 15-foot confining layer/unit underlies the UPRM in the vicinity of the BROS property. The confining unit is not continuous throughout the property due to local stratigraphic variation and impacts from prior sand mining operations. A predominantly downward head from the UPRM to the UMPRM allowed the flow of contaminants from the upper aquifer to the next lower aquifer.

The UMPRM ranges in thickness from 30 to 60 feet. It is characterized by moderately to well-sorted sands with minor clay interbeds of limited extent. A basal sandy gravel sequence has been observed in the vicinity of the BROS site and is important in regard to chemical of concern (COC) transport. Moving in a southeasterly direction away from the property, the contamination tends to be confined to this more permeable gravel zone at the bottom of the UMRPM. Southeast of the BROS property, aquifer zones above this basal unit are relatively free of BROS constituents.

Groundwater flow in the shallow UPRM aquifer exhibits a radial pattern (i.e., flow in all directions) away from the property, centered about a high in the west central portion. There is some seasonal variation to water levels and the flow is impacted by precipitation events. Overall, the primary direction of shallow flow is towards LTC (to the northeast).

Groundwater flow in the UMPRM aquifer is towards the southeast. The plume extends some 2400 feet from the southeastern extent of the property boundary.

The conceptual model for Groundwater Work indicates that during the lagoon operations, contamination migrated from the UPRM to the UMPRM, predominantly near the southeastern quadrant of the property. Contaminated groundwater then proceeded to migrate downward (due to advective flow within the aquifer system and the physical/geochemical characteristics of the contaminated water) until reaching the basal gravel zone of the UMPRM. The contamination then migrated in a southeasterly direction off the property.

It has been reported that the OU-1 lagoon remedial action eliminated upwards of 90 percent of the source material. This supposition is supported by the presence of a noticeably cleaner groundwater zone beneath the current areas of residual source material, but above the deeper contamination at the base of the UMPRM. Detailed groundwater flow and modeling information are provided in the RI/FS reports.

The main source of potable water in the area is groundwater. The sources for groundwater are primarily individual private wells, but efforts are underway to expand the public water supply infrastructure. Residential well sampling conducted in the area indicated that BROS constituents are not currently impacting any domestic private or public supply wells. To ensure that this remains the case, a Classification Exception Area/Well Restriction Area (CEA/WRA -- an institutional control mechanism administered through the State of New Jersey) has been established. The CEA/WRA essentially prohibits the installation of wells within the areas impacted by the BROS plume. The CEA/WRA may be modified (i.e., reduced) in the future based on the success of the proposed remedial actions.

An extensive array of monitoring wells has been installed, samples analyzed, and aquifer testing completed to determine the horizontal and vertical extent of the groundwater plume, its chemical constituents and flow patterns. Discrete vertical sampling/profiling was accomplished through the use of screened auger sampling techniques to evaluate the three dimensional extent of contamination, thereby ensuring contaminated zones were not missed.

One focus of the Phase 2 RI//FS was to identify the potential for secondary (post-waste oil lagoon) sources of contamination to impact the groundwater system. In that regard, two significant or principal threats to groundwater have been noted. The first is an area of dense residuals, derived from the acid-wash process in the lagoon, referred to as the groundwater contamination at the base of the UMPRM on-property. This slug of highly contaminated material, centered in the vicinity of Monitoring Well 26, continues to be a source of contamination downgradient or southeast of the site in the UMPRM aquifer. These residuals exhibit low pH and high levels of chlorinated organics. The second principal threat to groundwater involves areas with large quantities or thicknesses of LNAPL. The LNAPL is found both floating on the water table, above the water table and below the water table. Areas with free phase LNAPL appear to be of the most concern, due to the potential mobility of this material. Additional information concerning these principal threat residuals are found in the Nature and Extent of Contamination section of this Proposed Plan.

Land Use

Much of the land is undeveloped swamp and streams flowing northward to the Delaware River, interspersed with some agricultural and a few residential properties. A truck repair garage is located a few hundred feet north of the site and the Chemical Leaman Tank Lines Superfund site, an active industrial operation, is approximately one-half mile west of the site. Currently, most areas impacted by the site are zoned R-2 (Residential) by Logan Township. The R-2 designation includes a minimum two-acre lot area and allows for single family, agricultural, home occupations, parks, playgrounds and recreational facilities, governmental uses, social clubs and other non-profit institutions, schools and places of worship.

The sandy peninsula area, southeast of the former waste oil lagoon, and Swindell Pond have recently been donated to the New Jersey Green Acres Program. This parcel is about 21 acres in size, including the approximately 12-acre pond. Under the agreement with Green Acres, access to the property will be granted to conduct any necessary remedial actions. While it will take some time to manage the groundwater contamination beneath this portion of the site, minimal contamination in the shallow subsurface on this property is to be remediated and testing of the pond indicates that it is essentially free of BROS constituents. The remedial actions identified in this Proposed Plan will leave the property viable for future use.

Based on the levels of contamination and potential for completion of numerous exposure pathways, future land use is a factor in managing the site. However, as previously noted, three perpetual deed restrictions have been recorded for the property. The provisions were previously outlined in the introductory section of this plan.

It is proposed that these three deed restrictions be formally recognized as part of the Proposed Plan and preferred remedy for the BROS site and continue in perpetuity with the land.

Cultural Features

Five zones of cultural interest, including a potential prehistoric occupation area northeast of the project area, two areas around the Lock Farmstead where there could be early 19th century activities, a small area east of Route 295 and the bluff area on the western side of the Keller Farmstead were identified. While these areas were considered zones of archaeological sensitivity, none appear to be located in areas which will be impacted by the proposed remedial actions.

Rare, Threatened and Endangered Species

No rare, endangered or threatened species have been sighted during the Phase 2 field survey activities. The Bald eagle, Cooper's hawk and Red-headed woodpecker were identified by the National Heritage Program as species present near the BROS site. The Bald eagle and Red-headed woodpecker are not likely inhabitants, due to the lack of required habitat. For risk evaluation purposes, the Eastern screech owl was used as a representative surrogate for the Cooper's hawk, as a small raptor with a small home range. However, no risks to the Eastern screech owl in excess of the reference area were noted for the site.

Nature and Extent of Contamination

The types and extent of contaminated media both on- and off-property make the BROS site very complex from a risk management and remediation standpoint. In addition to considerable volumes of on- and off-property groundwater contaminated with organic compounds, there are a number of soil hot spots and LNAPLs with organic, inorganic and PCB contamination, and sediment with high concentrations of lead and PCBs.

It is estimated that over 300,000 cubic yards of COC-contaminated soil remain on-property with levels above preliminary remediation goals (PRGs). It is also estimated that over 100,000 gallons of free-phase LNAPL are present, significant amounts of residual LNAPL (perhaps over one million pounds) remain, and roughly 350 million gallons of groundwater are contaminated.

While the 13-acre waste oil lagoon has been remediated and the surface of the production area cleaned, the subsurface outside of the former lagoon area footprint has significant residual contamination. There are also some areas of residual contamination beneath the former lagoon and areas where mobile LNAPL has re-infiltrated into formerly remediated areas.

In summary, the areas of concern both on-property and off-property include:

- *Soil and Associated Hot Spots* – Soil Hot Spot around Monitoring Well (MW) 32 (also known as Hot Spot 1), the Pepper Building Soil Hot Spot (also known as Hot Spot 2), Debris/Fill Area, West Side Property, and the Former Process Area.
- *LNAPL* – Free and residual LNAPL wherever it occurs on the BROS site (widely distributed geographically and both above, at and below the water table), but including the Hot Spot around MW-32, the Pepper Building Hot Spot, Debris/Fill Area, West Side Property, South Side Property, and the North Swale Area.
- *Shallow Groundwater* – UPRM aquifer primarily on-property. Figure 3 provides the distribution of shallow groundwater contamination.
- *Deep Groundwater* – UMPRM aquifer both on- and off-property. The off-property groundwater plume extends some 2400 feet to the southeast of the property boundary. Figure 4 provides the distribution of deep groundwater contamination.
- *Wetland Sediments and Surface Water* – Sediment and surface water in LTCS and CS. A concentration-effects model was used to assist in the evaluation of wetland areas at the site. The general framework to categorize risk from exposure to the chemicals of potential environmental/ecological concern (COPECs) included mapping of three distinct severity of risk zones. The zones were labeled the *De Manifestis*, *Intermediate* and *De Minimis* zones. The table below provides some preliminary information on the three zones. Figure 5 shows the geographic distribution of the areas.

Wetland Zones/Areas of Concern

Severity of Risk	Risk Characterization/ Approach to Risk Reduction	Description/ Location
De Manifestis *(DMZ)*	Risks are high and considered manifestly intolerable. Action to reduce risk is required.	10.63 acres. Area immediately east of the former lagoon and an impacted area just north of Route 130.
Intermediate *(IZ)*	Risks are between DeManifestis and DeMinimis zones. Risk reduction may be considered.	12.60 acres. The one-hundred-foot area surrounding ("halo-like") the DeManifestis Zone.
De Minimis	Risks are so low that they are considered negligible. No action warranted.	Areas outside the Intermediate Zone but still within the influence of the site.

Each of the areas of concern is described in depth in the RI/FS documents.

Of the remaining residual wastes, LNAPLs with high PCB levels in close proximity to the outline of the former lagoon, and low pH waters contaminated with chlorinated volatile organic compounds (CVOCs) present in a zone at the bottom of the UMPRM aquifer immediately beneath the on-property area are considered the principal threat wastes associated with the Groundwater Work. Residual contamination in the *De Manifestis* Zone contains the most significant wastes related to the Wetland Work.

The UMPRM principal threat area includes a slug of contaminated groundwater in a 25 to 30-foot thick zone which encompasses approximately 15.06 acres in areal extent. The delineation of the extent of this contaminated groundwater zone is the area which exceeds 1,000 micrograms per liter (ug/L) total CVOCs. This contaminated groundwater is bounded on the bottom by a confining clay unit within the UMPRM aquifer. The upper surface of the clay unit forms a bowl-shaped depression which provides some structural control over the movement of the contaminated groundwater. This slug of water exhibits a dense non-aqueous phase liquid (DNAPL) like condition, in that the more highly contaminated water resides in the bowl shaped depression at the base or bottom of the aquifer, due to its physical properties including fluid density and low pH (as low as the 2-3 range). It is reported in the Phase 2 RI that this body of higher density, low pH-contaminated water was a result of the use of sulfuric acid in the oil recovery processing activities conducted at the site. It is important to note that multiple tests for the presence of DNAPL in the UMPRM and all other areas of the site were negative.

The LNAPL contamination is very complex and includes contaminated oily fluids of different viscosities. Recent investigatory activities completed by EPA estimate that 107,000 gallons of LNAPLs remain above, at and below the water table. It is estimated that up to 40,500 gallons of free phase LNAPLs are recoverable. To date, EPA actions have removed approximately 11,000 gallons of the recoverable LNAPLs. The recovered oil-like LNAPL contained high concentrations of BROS-related constituents including PCBs, BTEX (benzene/toluene/ethylbenzene/xylene), and chlorinated organics. Once extracted, the LNAPL was properly disposed at an off-site facility.

Soil and shallow groundwater contamination is mostly associated with areas exhibiting the presence of LNAPL. The contamination levels in both soil and shallow groundwater trend lower with increasing distance from LNAPL locations. Similarly, wetland sediment contamination is highest in areas impacted by LNAPLs and residuals.

Table 1 provides a general breakout of classes of COCs at the site by media. The RI/FS and human health and ecological risk assessments provide a full explanation and understanding of impacts that human health chemicals and COPECs have on site-related risk.

Generally speaking, while a large number of chemical constituents are present in the various site media, only a few compounds drive the carcinogenic and non-carcinogenic human health risks. A brief summary of the COCs and COPECs (by media), focusing on the chemicals which drive human health risk, is presented below.

Soils: Arsenic, total PCBs, trichloroethene (TCE), naphthalene, phenanthrene, phenol, and total xylenes.

Total volatile organic compounds (VOCs) in soil average 699 milligrams per kilogram (mg/Kg) at soil Hot Spot 1 and 164 mg/Kg at Hot Spot 2. Total TCE (along with tetrachloroethene and dichloroethene compounds) concentrations exceeding 100 mg/Kg and benzene exceeding 10 mg/Kg are also present at soil Hot Spot 1.

LNAPL and Shallow Groundwater: 1,2-dichloroethane, 1,2-dichloropropane, benzene, bis (2-chloroethyl) ether (BCEE), chloroethane, chloroform, methylene chloride, tetrachloroethene, thallium, TCE, and vinyl chloride.

While cleaning up site soils to New Jersey non-residential guidance levels is a remedial goal, current direct exposure to shallow groundwater and LNAPL is limited based on existing deed restrictions and clean soil cover at the surface. Two exposure pathways, construction-related activities and the potential for future exposure on-site via the vapor intrusion mechanism, are two important scenarios that were evaluated. In shallow groundwater, benzene and TCE concentrations exceeding 500 ug/L extend over an approximate one-acre area centered about MW-32. Metals such as iron, manganese lead and arsenic are also present exceeding groundwater quality criteria. Most LNAPL samples contained greater than 50 mg/Kg PCBs, with Arochlor mixtures 1254 and 1260 predominating.

Deep groundwater: Arsenic (not site-related), BCEE, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, benzene, cis-1,2-dichloroethene, tetrachloroethene, TCE, and vinyl chloride contribute the most to the site-related risk.

Chlorinated VOCs, including TCE and its breakdown products, ranging from 2,000 to 10,000 ug/L are found in the more highly contaminated areas. BTEX concentrations as high as 4,000 ug/L were recorded during investigations and BCEE concentrations ranged from 9 to 3,800 ug/L. Over most of the southeastern portion of the on-property area, total benzene and TCE concentrations exceed 1,000 ug/L. Metals such as iron, manganese, lead and arsenic are also present exceeding groundwater quality criteria. In the principal threat zone, pH ranges from 2 to 5.

While numerous metals are detected in groundwater, aluminum, iron and manganese are present beneath the entire site at concentrations above groundwater quality standards (i.e., non-health-based taste, odor and aesthetic characteristics).

Wetland Sediment: COPECs include the primary ecological stressors PCBs, lead and mercury, and secondary stressors including barium, cadmium chromium, cobalt, copper, nickel, vanadium and zinc.

Lead values in the more highly contaminated area (the DMZ) exceed 1,000 mg/Kg in the shallow sediment (0 to 6 inches). PCB values exceeding 100 mg/Kg are also present in this zone. Select areas exhibit total petroleum hydrocarbon levels exceeding 10,000 mg/Kg.

Based on the site-specific data, contamination gradients exist in all media. Soil levels tend to reduce as one moves away from the areas with residual LNAPL. Shallow and deep groundwater contaminant concentrations similarly decrease with distance from the property. In the wetland hydric soil/sediment, there is a rapid decrease in COPEC concentrations both horizontally and vertically outside the area containing residual LNAPL (the DMZ area).

SCOPE AND ROLE OF RESPONSE ACTION

The first operable unit response actions provided the community at risk with an alternate water supply to prevent ingestion of contaminated water, eliminated the waste oil lagoon and tank farm wastes as potential sources, and reduced the risk associated with direct contact by placing clean fill at the land surface on the property. This second operable unit provides for the remediation of groundwater and the more highly contaminated wetland sediments while seeking to address the residual source materials in the form of contaminated soils and LNAPLs. It represents the final planned operable unit for the BROS site.

The primary objective of this response action is to address the post-OU-1 risks to human health and the environment due to residual contamination in LNAPL, sediments and soil, as well as contaminated groundwater on the property and the groundwater plume emanating from the site.

The site model reveals that VOCs, semi-volatile organic compounds (SVOCs), inorganic compounds and PCBs are present in elevated concentrations in different media on and about the property. As a starting basis, the selected remedy recognizes that source control measures were implemented on-property for the tank farm, the 13-acre waste lagoon, a drum disposal east of the former lagoon, and to some extent, the LNAPL near the Pepper Building and MW-32 areas. The RI also reports that despite some post-EPA Phase 1 (OU-1) remediation efforts, residual contamination exits in the area of the former lagoon. While this residual contamination, for the most part, appears to be material present in areas adjacent to and beneath the former excavation, some recontamination of the lagoon area may have occurred.

The highly contaminated, low-pH groundwater located immediately beneath the property and LNAPL and residually contaminated soils constitute the principal threat wastes at the site. These media are contaminated with a wide variety of compounds including chlorinated organics and metals. The LNAPL and residual LNAPL exist primarily in areas west and north of the former lagoon fingerprint. Successful completion of source control is important to the full realization of the benefits from the remedial actions proposed in this document. The site model also reveals that measures taken to reduce sources, cleanup of off-property groundwater and cleanup of the more highly contaminated sediments in the wetland area can achieve sufficient reductions in risk to allow the off-property and on-property areas to become useful as residential and commercial/industrial areas, respectively. The model also notes that past practices have left some residual contamination which may take a long time to remediate or may never achieve a cleanup level sufficient to forgo the use of some engineering or institutional control.

SUMMARY OF SITE RISKS

As part of the RI, EPA conducted a baseline human health risk assessment to determine the current and future effects of contaminants on human health and an ecological risk assessment to address environmental concerns. The human health risk assessment was based on the reasonably anticipated future land use as non-residential (i.e., commercial/

industrial) for the on-property areas and residential for off-property areas. Health effects for both children and adults in an off-property residential setting that potentially could result from current or future contact with contaminated groundwater along with a number of potential current and foreseeable future human exposure pathways on-property were evaluated.

Information on both the Human Health Risk Assessment (HHRA) and ecological risk analysis aspects of the project are provided below. It is EPA's current judgment that the Preferred Alternative is sufficient to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Human Health Risk Assessment

The baseline human health risk assessment evaluated the potential risks and hazards associated with the site.

EPA's acceptable levels of excess lifetime cancer risk and non-cancer hazards are presented in Highlight 1, *What is Risk and How is it Calculated.*

A summary evaluation of the potential risks and hazards posed by the site is presented below. A description of the hazards associated with the site is presented in the Nature and Extent of Contamination section of this Proposed Plan. In summary, elevated levels of various VOCs/CVOCs (including benzene, TCE, dichloroethene and vinyl chloride), SVOCs (including BCEE) and PCBs in various media across the site trigger an exceedance of the cancer risk threshold most frequently. Non-cancer risks are primarily driven by TCE, arsenic (not site-related), benzene, vinyl chloride, cis-1,2-dichloro-ethene, phenanthrene, naphthalene and total xylenes.

Reasonable potential on- and off-property human exposure scenarios were developed based on the most current site information. Receptors included the following:

- Adult and child residents (off-property shallow and deep groundwater potable use;
- Adult and child agricultural use (off- property shallow and deep groundwater spray irrigation;
- Trespassing teenagers (on-property soil);
- Groundskeepers (on-property soil);
- Construction workers (surface and subsurface soil and shallow groundwater);
- Utility workers (surface and subsurface soil); and,
- Adult and child recreators (surface water and sediment in LTCS and Cedar Swamp).

Chemical-specific toxicity factors, available from

HIGHLIGHT 1

WHAT IS RISK AND HOW IS IT CALCULATED?

A Superfund baseline human health risk assessment is an analysis of the potential adverse health effects caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these under current- and future-land uses. A four-step process is utilized for assessing site-related human health risks for reasonable maximum exposure scenarios.

Hazard Identification: In this step, the contaminants of concern at the site in various media (i.e., soil, groundwater, surface water, and air) are identified based on such factors as toxicity, frequency of occurrence, and fate and transport of the contaminants in the environment, concentrations of the contaminants in specific media, mobility, persistence, and bioaccumulation.

Exposure Assessment: In this step, the different exposure pathways through which people might be exposed to the contaminants identified in the previous step are evaluated. Examples of exposure pathways include incidental ingestion of and dermal contact with contaminated soil. Factors relating to the exposure assessment include, but are not limited to, the concentrations that people might be exposed to and the potential frequency and duration of exposure. Using these factors, a "reasonable maximum exposure" scenario, which portrays the highest level of human exposure that could reasonably be expected to occur, is calculated.

Toxicity Assessment: In this step, the types of adverse health effects associated with chemical exposures, and the relationship between magnitude of exposure (dose) and severity of adverse effects (response) are determined. Potential health effects are chemical-specific and may include the risk of developing cancer over a lifetime or other non-cancer health effects, such as changes in the normal functions of organs within the body (e.g., changes in the effectiveness of the immune system). Some chemicals are capable of causing both cancer and non-cancer health effects.

Risk Characterization: This step summarizes and combines outputs of the exposure and toxicity assessments to provide a quantitative assessment of site risks. Exposures are evaluated based on the potential risk of developing cancer and the potential for non-cancer health hazards. The likelihood of an individual developing cancer is expressed as a probability. For example, a 10^{-4} cancer risk means a "one-in-ten-thousand excess cancer risk"; or one additional cancer may be seen in a population of 10,000 people as a result of exposure to site contaminants under effects are not expected to occur. The conditions explained in the Exposure Assessment. Current Superfund guidelines for acceptable exposures are an individual lifetime excess cancer risk in the range of 10^{-4} to 10^{-6} (corresponding to a one-in-ten-thousand to a one-in-a-million excess cancer risk). For non-cancer health effects, a "hazard index" (HI) is calculated. An HI represents the sum of the individual exposure levels compared to their corresponding reference doses. The key concept for a non-cancer HI is that a "threshold level" (measured as an HI of less than or equal to 1) exists below which non-cancer health.

EPA's Integrated Risk Information System (IRIS) were utilized in the evaluation. When IRIS values were not available, provisional toxicity criteria approved by EPA were utilized.

Risk estimates were initially provided for reasonably maximum exposed (RME) individuals (i.e., the highest exposures that are reasonably expected to occur). When the RME risk exceeded acceptable benchmarks, central tendency exposure (CTE) calculations were provided.

From an overall risk management perspective, the following general observations are noted:

1. Deep groundwater exposures associated with water derived from the base of the UMPRM aquifer located south of Swindell Pond yielded potential cancer and non-cancer risks for both adults and children. The combined adult/child carcinogenic RME risk associated with ingestion and showering (dermal plus inhalation) exposure was estimated at 2.8 X 10-2 (or nearly three in one hundred). The hazard index (HI) for the same scenario was 27. Three chemicals, TCE, vinyl chloride and BCEE, comprise more than 95 percent of the total RME cancer risk. About 95 percent of the non-cancer RME risk was attributable to TCE, arsenic, benzene, vinyl chloride and cis-1,2-dichloroethene.

2. Risk calculations for residential use of AOC-1 (UPRM shallow groundwater zone on-property) and AOC-3 (the principal threat area of the UMPRM immediately beneath the BROS on-property area) were not calculated based on the belief that ICs would prohibit the use of this water for residential ingestion/ showering/dermal purposes. EPA notes that the risk levels for AOC-1 and AOC-3 beneath the BROS property would exceed those provided for deep groundwater exposure (noted in the above observation) for the area south of Swindell Pond.

3. Estimated adult and child cancer and non-cancer risks were above their respective thresholds for both the RME and CTE scenarios for ingestion and showering with groundwater derived from off-property areas (termed deep groundwater AOC-4 in the RI) located within the BROS plume. Water from shallow zones off-property (and not in the immediate vicinity of BROS residual contamination/LNAPL) is not contaminated with BROS constituents. The combined cancer ingestion and showering (dermal plus inhalation) risk for BCEE alone was 2.6 X 10^{-6} (2.6 in one million).

4. Agricultural use of off-property deep groundwater included adult, child and combined adult/child cancer risks for the RME individual exceeding the 10^{-6} (one in a million) point of departure. BCEE, TCE and vinyl chloride are the primary constituents which drive risk.

5. Ingestion of water from a fountain on-property (termed deep groundwater AOC-3 in the RI) during recreational activities (a very conservative exposure pathway given the existing deed restrictions and other ICs in place for the site) yielded both cancer and non-cancer risks in excess of threshold values. The total cancer RME risks for both adult and child were calculated at 2 X 10^{-4} (two in ten thousand). The total RME hazard index (non-carcinogenic exposure) for all chemicals was 5.2. While deed restrictions prohibit the installation of wells on-property, it is recognized that risks based on ingestion and showering exposure from on-property groundwater would significantly exceed EPA's acceptable risk range of 10^{-4} to 10^{-6} (one in ten thousand to one in a million).

6. Groundwater exposure to construction workers represents a risk at the conservative end of EPA's acceptable range, with PCBs yielding an RME dermal carcinogenic exposure of 2.0 X 10^{-6} and a non-carcinogenic RME risk hazard quotient of 4.0, which exceeds the threshold of 1.0.

7. Both cancer and non-cancer risks were determined to be within an acceptable range for the trespasser and groundskeeper who might come into contact with surface soils.

8. Construction workers and utility workers coming into contact with surface or subsurface soil within any areas of concern were not subject to risks exceeding threshold values.

9. Recreational exposure to sediment and

surface water from LTCS and CS were not subject to risks exceeding cancer or non-cancer benchmarks.

10. The vapor intrusion pathway (potential future-use condition only, as there is no complete exposure under current site conditions) is estimated to exhibit risks above threshold values attributable to LNAPL, shallow groundwater and soil contamination. Soil Hot Spots 1 and 2 were the primary contributors to both cancer and non-cancer risks. Cancer-related risks were also associated with the west side property area of concern and overall site areas where LNAPL and shallow groundwater contamination exist (essentially the entire BROS on-property area).

11. The concentrations and estimated exposures associated with soils and shallow groundwater are low, except where free or residual LNAPL is present. The combined carcinogenic RME exposure from LNAPL, shallow groundwater and soil-based releases was 3.0 X 10^{-3} (three in a thousand) for Soil Hot Spot 1, and 2.4 X 10^{-3} for the remaining BROS property in the former lagoon area. The combined non-carcinogenic risk was highest at Soil Hot Spot 1 where the hazard quotient for the RME was 54.

Multiple source area exposure scenarios were also evaluated. The hypothetical possibility remains that combinations of exposures could occur which might lead to total site risks higher than the estimates presented for individual areas of concern. Additional details on exposure scenarios and site-related cancer and non-cancer risks can be found in the HHRA.

Ecological Risk Assessment

The primary objective of the ecological assessment was to identify and characterize the potential risks posed to wildlife receptors as a result of contaminant releases. A secondary objective was to determine the need, if any, and potential consequences of performing a response action at the site, from an ecological perspective. Highlight 2 provides an overview of the multi-step process utilized for assessing site-related ecological risks. Surface water, sediments and soils are considered to be sources of ecological exposure at the site.

HIGHLIGHT 2

THE EXCOLOGICAL RISK ASSESSMENT PROCESS

Problem Formulation - a qualitative evaluation which identified ecosystems potentially at risk; listed potential stressors, pathways, and effects; selected ecological endpoints for further study; and composed a conceptual site model.

Exposure Assessment - a quantitative evaluation of contaminant release, migration and fate; characterization of exposure pathways and receptors and measurement or estimation of exposure point concentrations.

Ecological Effects Assessment - toxicity profiles summarizing the potential adverse ecological effects of each COPEC were derived form the literature, toxicity reference values were derived, effects on growth, reproduction and survival of aquatic and terrestrial species were described, and significant fate and transport characteristics were provided.

Risk Characterization- ecological risks posed by COPECs at the site were identified and summarized. Risks were estimated using general comparisons and hazards quotients (HQs) calculated with estimated exposure and toxicity reference values for each receptor species.

The ecological risk assessment addressed four main areas including LTCS, Cedar Swamp, Swindell and Gaventa Ponds, and the debris fill and transition areas. LTC and LTC Swamp lie to the east and north of the property. Further downstream, upon entering into Cedar Swamp, the swamp and drainage channels are freshwater tidal streams. A tide gate separates flow from LTCS and Cedar Swamp. Swindell Pond and Gaventa Pond are south and southwest of the property and are separated by a peninsula with remnants of former sand mining access roads.

LTCS and CS have been further divided into physical segments to facilitate discussion of remedial activities. These areas include:

- LTCS-I, the area south of Route 295;
- LTCS-II, between Route 295 and Route 130;
- LTCS-III, between Route 130 and Route 44;
- CS-I, between Route 130 and 44; and,
- CS-II, the remaining portion of site-related CS.

To address the complexity of the various levels of contamination present at the site, further definition of areas of concern was accomplished by delineating concentration zones. For BROS, these included the following:

The *De Manifestis* Zone (DMZ): An area represented by sediment total petroleum hydrocarbon concentrations above 10,000 mg/Kg (defined as residual NAPL by NJDEP), constituents which consistently exceed severe effects levels (SELs) for several BROS COPECs, areas where vegetal shifts are currently evident, areas where surface water samples exceed water quality criteria in greater than 50 percent of the samples (for site COPECs), and areas subject to erosion. The DMZ is primarily located adjacent to the on-property areas, just east of the former lagoon. This zone also exhibits high levels of lead (greater than 1,000 mg/Kg) and PCBs.

The *Intermediate* Zone (IZ): A transitional area outside the DMZ with some chemicals at elevated concentrations. The IZ forms, generally speaking, a 100-foot buffer around the DMZ.

The *De Minimis* Zone (DM): A zone which is characterized by conditions similar to the chosen site-specific reference areas.

It is noted that the BROS on-property area has been restored to an upland grass habitat with clean cover soils. Past remedial actions have eliminated surface soil as a continued source of contamination to the LTC Swamp area. Contaminated groundwater and residual subsurface contamination remain potential sources of contamination to the wetland.

Based on review of the analytical and field survey data, areas of ecological effects (from chemical exposure) were identified in LTCS-II and LTCS-III, but not in LTCS-1 or CS I/II. Within LTCS-II and III, the *De Manifestis* Zone had significant effects while no significant effects were noted in the *De Minimis* Zone. The IZ is a zone of transition.

Adverse effects on vegetation, aquatic invertebrates, small mammals, birds and carnivores were selected as assessment endpoints. For LTCS, vegetation communities, aquatic communities, higher trophic level mammals (red fox) and higher trophic level birds (Eastern screech owl) were selected as assessment endpoints. For CS, aquatic organisms (white perch), piscivorous (fish eating) birds (great blue heron), higher trophic level mammals (red fox) and higher trophic level birds (Eastern screech owl) were selected. Receptor species considered representative of local wildlife populations were selected based on their potential exposure and susceptibility to the adverse effects of site contamination. Average and maximum exposure scenarios were considered due to the mobility of receptor species.

Sediments and surface water were considered when completing the risk calculations. After a rigorous screening process, COPECs were identified. These included lead, mercury and total PCBs as primary COPECs, and secondary COPECs consisting of barium, cadmium, chromium, cobalt, copper, nickel, vanadium and zinc.

Potential risks were estimated by a variety of methods depending on the assessment and measurement endpoint being evaluated. Direct comparison against benchmarks was performed in those cases where this comparison was relevant. The HQ Method was also utilized in this assessment to characterize the possible ecological hazard. The HQ (hazard quotient) is the ratio of the concentration in the environmental medium to the corresponding toxicity benchmark. If an HQ exceeds one, there is concern for possible adverse effects. The potential exposure and the associated potential ecological risk should actually be much lower however, due to the decreased concentration gradients with distance from the DMZ, limited site accessibility, and the likely decrease in chemical concentrations over time based on the elimination of the primary source.

Overall, the *DeMinimis* Zone in LTCS I was designated a no apparent ecological effects zone due to surface water concentrations similar to those in the reference area, filtered surface water results below surface water quality benchmarks, and sediment COPEC concentrations overlapping the ranges observed in the reference areas.

The risks in the *Intermediate Zone* do not appear to be ecologically significant. Assuming a 100-foot halo zone around the DMZ, only slight elevation in HQ values was observed. For the Eastern screech owl, only the secondary COPEC chromium (at 2.4) and zinc (at 1.0) had increased HQ values.

The DMZ represents an area where historical lagoon overflows appear to have resulted in a vegetation shift (to *phragmites* from red maple vegetation community). Large quantities of residual

LNAPL and metals are present in the DMZ. In this zone, calculated risks to red fox and Eastern screech owl were higher than the reference areas. However, in LTCS II/III (the areas of highest concern), no ecological risk exceeding an HQ of 1.0 was noted for the red fox (representative of the upper trophic level predatory mammal) or the Eastern screech owl (representative of the upper trophic level predatory avian population). Although not an ideal habitat for mink, HQ values were also calculated for this sensitive receptor. HQ values for mink were well below one.

Similar results were obtained for areas of CS, where great blue heron (receptor representing piscivorous bird population), red fox and Eastern screech owl had HQ values less that one. Risks to white perch (representing water column biota) and mummichugs (benthic feeding forage fish species) were not considered significant.

Swindell Pond sampling indicated no observed results above aquatic benchmarks. It was concluded that Swindell Pond does not contain BROS-related COPECs at concentrations of potential ecological concern. Potential adverse effects to benthic organisms, however, are probable within a limited area surrounding the seep area of Gaventa Pond.

As previously noted, while habitat for threatened and endangered species potentially occurs in Gloucester County, no rare plants or animals have been observed on the site.

REMEDIAL ACTION OBJECTIVES

It is EPA's current judgment that the Preferred Alternative identified in this Proposed Plan is necessary to protect public health and the environment from actual and threatened releases of hazardous substances, pollutants or contaminants from the site which may present an imminent and substantial endangerment to public health or welfare.

Remedial action objectives (RAOs) were developed in accordance with the National Contingency Plan and current EPA guidance. RAOs were developed for each media of concern considering on-property use in the commercial/industrial category, and off-property use under a residential/agricultural/recreational setting.

The RAOs for shallow groundwater on- and off-property include:

- Protection of the public against ingestion and direct contact with VOCs, SVOCs and metals in the groundwater above preliminary remediation goals (PRGs – including the cleanup of shallow groundwater or reductions in movement to ensure that contaminants do not occur at potential exposure points);
- Protection against vapor intrusion from VOCs, SVOCs and PCBs in groundwater above PRGs; and,
- Protection of the public and utility workers against direct contact with VOCs, SVOCs LNAPL, PCBs and metals in groundwater above PRGs.

From a numerical standpoint, the PRGs identified, to the extent practicable at this stage for shallow groundwater, include the lower of federal or state maximum contaminant levels (MCLs) or the state groundwater quality criteria which are considered ARARs for the site. However, there is the potential for a future waiver of these chemical-specific requirements based on the ability of the proposed remedial alternatives to reduce localized areas to below threshold levels. Any such waiver would be subject to the NCP process including public participation. The following table provides numerical values for key site COCs. Values for all of the groundwater COCs are found in the RI. It is believed that the RAOs for off-property shallow groundwater are achievable in a reasonable period of time.

Groundwater PRGs

Analyte/ Contaminant Group	NJDEP GWQC	Federal MCL
Volatile Organic Compounds (ug/L)		
Benzene	1	5
TCE	1	5
Vinyl Chloride	1	2
Semi-Volatile Organic Compounds (ug/L)		
BCEE	7	-
Polychlorinated Biphenyls (ug/L)		
Total PCBs	0.5	0.5

The remedial action objective for deep groundwater is to restore and protect against groundwater ingestion from COCs above federal and state MCLs and New Jersey groundwater quality standards (GWQSs). While complete restoration of the deep groundwater to achieve chemical-specific ARARs is the primary goal, conditions in the principle threat zone (PTZ) will have an effect on the restoration time frame. It also remains a possibility that complete restoration of the PTZ may be technically impracticable. It is anticipated that the deep groundwater outside the PTZ can be restored within a reasonable time period. The PRGs noted for shallow groundwater (above) also apply to deep groundwater. Due to the depth of deep groundwater, it is not believed that exposures from vapors or worker direct contact will be an issue.

The RAOs for soils on- and off-property include:

- Protection against vapor intrusion/inhalation from adsorbed VOCs, SVOCs and PCBs above PRGs;
- Protection against impacts to groundwater from adsorbed VOCs in soil above PRGs;
- Protection of public and utility workers against direct contact with adsorbed VOCs, SVOCs, LNAPLs, PCBs and metals in soil off-property on the south side of the property above PRGs; and,
- Protection against the uptake of adsorbed VOCs, SVOCs and metals into soil in crops off-property.

Soil cleanup levels or risk-based preliminary remedial goals for surface soils at the site were developed in accordance with EPA Risk Assessment Guidance (RAGS) Part B. The PRGs were based on a conservative land use scenario and included a target risk for carcinogens in the range of 10^{-4} to 10^{-6} and a hazard index of 1.0 for non-carcinogens.

There are no chemical-specific ARARs for contaminated soils. The PRGs for soils are similar to NJDEP's residential and commercial/industrial use soil cleanup criteria for off-property and on-property areas, respectively. In addition, NJDEP has developed impact to groundwater soil cleanup criteria to address sources of groundwater contamination in subsurface soils. These were also considered in the development of soil PRGs for the site. Numerical values for key COCs are provided in the following table.

Soil PRGs

Analyte	On-Property NJDEP Restricted Use SCC	Off-Property NJDEP Unrestricted Use SCC
Volatile Organic Compounds (mg/Kg)		
Benzene	13	3
Xylenes	1000	410
TCE	54	23
Semi-Volatile Organic Compounds (mg/Kg)		
Naphthalene	4200	230
TPH	10,000	10,000
Polychlorinated Biphenyls (mg/Kg)		
Total PCBs	2	0.49

As with the groundwater, while all reasonable efforts will be made to reduce contaminant levels in soil, return of the subsurface soils to the identified remedial goals will be difficult. The effectiveness of the remedial actions implemented at the site will be evaluated over a period of a number of years. Based on those evaluations, a determination will be made relative to the practicability of achieving the cleanup goals. Any appropriate changes to those goals would be subject to the NCP process.

The RAOs for LNAPL are similar to the soil objectives with the following amendments:

- Public and utility work protection from direct contact with adsorbed VOCs, SVOCs and PCBs is focused on the west side and south side properties;
- Consistent with State of New Jersey requirements, LNAPL should be removed and residuals contained, to the extent practicable; and,
- Off-property protection against public and ecological receptor direct contact with residual LNAPL and associated PCBs in soil and sediment is focused on the former seep area at Gaventa Pond.

LNAPL remediation represents a difficult site challenge. Factors such as the complexity of the geohydrology of the site, the extent and volume of both free phase and residual LNAPL, recontamination of some areas already cleaned up, and the presence of residuals beneath remediated areas (at depths greater than 25 feet) may make complete remediation of these materials impracticable. In an effort to reduce risk to the extent practicable while attempting to restore the site, a performance goal involving the removal of free phase LNAPL has been chosen (further information provided in Other Performance Goals section).

The goals for key wetland sediment contaminants include the following:

Wetland PRGs

Analyte	Proposed Level	Notes
Polychlorinated Biphenyls (mg/KG)		
Total PCBs	10 (surface average)	OU-1 on-site soil cleanup goal was 10 mg/Kg. Most total PCB levels outside the DMZ are less than 1 mg/Kg.
Metals (mg/Kg)		
Lead	1,000	OU-1 on-site soil cleanup goal was 1,000 mg/Kg. Most Intermediate zone lead in 250 to 500 mg/Kg range. SEL is 250 mg/Kg.

Other Performance Goals

It is estimated that the OU-1 activities reduced the quantity of waste at the site by about 90 percent. However, there is expected to be some difficulty in achieving full cleanup of the remaining 10 percent.

LNAPL, especially free phase LNAPL, is recognized as one of the principal threats at the site. EPA has been carrying out a passive free phase LNAPL extraction program with some success. The preferred alternative will improve on the free phase LNAPL extraction through the use of bioslurping (described in the Preferred Alternative). Based on inventories conducted by EPA, an estimated 107,000 gallons of free phase LNAPL is believed to be present on-site. Of this amount, it is estimated that 40,500 gallons are recoverable. EPA efforts to date have removed about 11,000 gallons. Therefore, a performance goal involving the extraction of 29,500 gallons of free phase LNAPL is being adopted. Confirmation of the performance criteria for the extraction of free phase LNAPL will be accomplished during the bioslurping design and pilot activities. Other performance measures may be established during the bioslurping design/pilot such as the quantity of shallow groundwater removed and the pounds of contaminants removed from the vapor-phased extraction. Monitoring will be conducted to evaluate the level of risk reduction achieved.

COC mass estimates were calculated (may be biased high due to the use of wells screened in the locations predicted to have the highest concentrations) for shallow and deep groundwater by area of concern. The preliminary goals for VOC and SVOC removal include the following:

- Top 40 feet /UPRM – VOCs = 5,525 pounds, SVOCs = 684 pounds
- 40 feet to 80 feet/UMPRM beneath the BROS property – VOCs = 1,753 pounds, SVOCs = 1,990 pounds
- 40 feet to 85 feet/UMPRM adjacent to/ downgradient of the site – VOCs = 54 pounds, SVOCs = 100 pounds

Multiple rounds of chemical treatment and biological treatment following the adaptive management process will be utilized to achieve the above mass reduction goals.

For the wetland areas, multiple lines of evidence determined the risks posed to ecologically relevant receptors outside the DMZ to be characterized by hazard quotients less than one, and were not significantly different than the reference areas selected in careful consultation with the EPA/State Biological Technical Assessment Group. Further, concentration gradients exist such that levels drop off dramatically with increasing distance from the DMZ. The fact that no HQ values were above one or above those observed in the reference areas for avian and mammalian terrestrial receptors indicates that BROS-related chemicals do not significantly affect those populations. Disruption of wetlands is always a factor when dealing with cleanup in that type of setting. For the above reasons, a lead cleanup level of 1,000 mg/Kg, while exceeding the severe effects level, has been adopted for areas outside the DMZ. As the DMZ will undergo an excavation activity, the levels of lead and PCB in the excavation zone will be reduced to below threshold values.

SUMMARY OF REMEDIAL ALTERNATIVES

Remedy components will employ treatment technologies, engineering controls and institutional controls. Remedial alternatives have been developed for soil, LNAPL, shallow groundwater, deep groundwater and wetlands. Generally speaking, EPA has looked toward meeting the goal of reducing toxicity, mobility and volume through treatment. Chemical and biological treatment technologies have been identified for the deep groundwater cleanup; vacuum extraction and water budget technologies are preferred to address residual source materials on-property; and contaminated wetland sediment will be managed by excavation (with off-site treatment/ disposal) and restoration techniques. The alternatives which passed the initial screening and received detailed analyses are provided in this section. The identification of the alternatives corresponds to the numbered list provided in the Groundwater and Wetlands FS documents. Summary cost and construction time frames for the alternatives are also provided.

Capital costs include those expenditures required to construct the remedial action. Operation and maintenance costs are those post-construction costs necessary to ensure or verify the continued effectiveness of the remedial action. Present worth costs, which include the monetary amounts needed to be set aside at the beginning of the project to ensure the availability of sufficient funds in the future to complete the work, will be provided in the Record of Decision.

It is believed that the preferred alternatives will achieve their desired results.

SOIL

Soil (Soil Hot Spots) alternatives would be combined with LNAPL and Shallow Groundwater technologies in the adaptive management approach. While soil vapor extraction (SVE), a seemingly viable technology for VOCs in soil, was not carried forward to the detailed alternative analysis, the bioslurping technology considered under LNAPL alternatives LNAPL 4/5 has a vapor removal component. SVE was not carried forward due to its inability to address the non-volatile contaminants (i.e., SVOCs, PCBs, lead and other inorganic constituents) present in the soil, as well as the very large volume of free phase LNAPL.

Alternative SHS-1: No Further Action, Unmonitored Natural Remediation

Estimated Capital Cost: $0
Estimated Annual O&M: $0
Estimated Total Cost: $0
Estimated Construction Time Frame: None

Alternative SHS-2: Institutional Controls, and Cover and Drainage Improvements

Estimated Capital Cost: $3,690,087
Estimated Annual O&M: $138,450
Estimated Total Cost: $6,857,626
Estimated Construction Time Frame: 36 months

ICs include the existing deed restrictions and the State CEA/WRA. Cover and drainage improvements will include regrading and the installation of specific engineered runoff channels to appropriately direct surface runoff and reduce infiltration.

Alternative SHS-3: Institutional Controls, Cover and Drainage Improvements, and In-Situ Treatment (via Phytoremediation)

Estimated Capital Cost: $5,175,087
Estimated Annual O&M: $174,450
Estimated Total Cost: $9,201,795
Estimated Construction Time Frame: 36 months

Alternatives SHS-3 and SHS-4 add an in-situ technology which will incorporate the use of hybrid poplar trees (or other appropriate species) to aid in site water budget control, as well as provide some shallow groundwater remediation through the development of root masses that enhance the movement of nutrients, increase microbial activity and improve in-situ biodegradation. This remedial measure will require some pilot work to identify the species of trees best suited for site conditions and the potential success of this measure. The Region in conjunction with phytoremediation/water budget management experts from the Agency's Environmental Response Team (ERT) is currently performing some pilot work in this area.

Alternative SHS-4: Institutional Controls, Cover and Drainage Improvements, In-Situ Treatment (via Phytoremediation), and Enhanced Biodegradation

Estimated Capital Cost: $7,167,687
Estimated Annual O&M: 174,450
Estimated Total Cost: $11,493,285
Estimated Construction Time Frame: 48 months

An enhanced bioremediation component was added to Alternative SHS-4.

Soil excavation alternatives were screened out during the FS. However, EPA believed that both hot spot and aggressive soil excavation alternatives were worthy of some consideration. The Agency independently developed the following two alternatives.

- Alternative SHS-5: Soil Hot-Spot Area Excavation Associated with the Pepper Building and Monitoring Well-32; and,

- Alternative SHS-6: Aggressive Soil Excavation Associated with the Former Production Area (including the Pepper Building and Monitoring Well-32 areas).

The estimated capital cost for SHS-5 is $34,600,000. The majority of this cost is associated with the excavation and off-site disposal of contaminated soil. It is estimated that hot spot excavation could be completed in 24 months.

The estimated capital cost for SHS-6 is $126,000,000. The majority of this cost is associated with the excavation and off-site disposal of contaminated soil. It is estimated that this larger-scale excavation activity could be completed in 48 months.

Upon comparison with the other alternatives for soil media, it was determined that the potential for recontamination and/or the amount of residual contamination which would not be removed through an excavation activity precluded further consideration of these alternatives.

LNAPL

Both free and residual LNAPLs are present above, at and below the water table on the site. Beyond the areas where LNAPL is present, contaminant of concern concentrations ultimately decline to non-detect levels in soils and shallow groundwater.

Alternative LNAPL-1: No Further Action

Estimated Capital Cost: $0
Estimated Annual O&M: $0
Estimated Total Cost: $0
Estimated Construction Time Frame: None

Alternative LNAPL-2: Institutional Controls, Cover and Drainage Improvements, Limited Off-Property Excavation (Gaventa Pond Seep and Green Acres Property), and Passive LNAPL Recovery

Estimated Capital Cost: $5,264,575
Estimated Annual O&M: $151,650
Estimated Total Cost: $9,091,675
Estimated Construction Time Frame: 60 months

The active LNAPL alternatives each employ the same ICs, cover and drainage components as the soil alternatives. Alternative LNAPL-2 adds excavation of contaminated LNAPLs/soils at the Gaventa Pond seep and Green Acres property and a passive LNAPL recovery activity. Passive LNAPL recovery would consist of continuing the program initiated by EPA. EPA has determined that this action, while having produced good results for a reasonable cost, is not sufficient to extract the remaining free phase LNAPL.

Alternative LNAPL-3: Institutional Controls, Cover and Drainage Improvements, Limited Off-Property Excavation (Gaventa Pond Seep and Green Acres Property), Passive LNAPL Recovery, and Containment (via Phytoremediation/ Alternative Final Cover)

Estimated Capital Cost: $6,804,575
Estimated Annual O&M: $187,650
Estimated Total Cost: $11,499,094
Estimated Construction Time Frame: 72 months

LNAPL-3 adds a water budget management (referred to as phytoremediation) and an alternative final cover to site remediation activities.

Alternative LNAPL-4: Institutional Controls, Cover and Drainage Improvements, Limited Off-Property Excavation (Gaventa Pond Seep and Green Acres Property), Passive LNAPL Recovery with Select Enhancements (Bioslurping), and Containment (via Phytoremediation/ Alternative Final Cover)

Estimated Capital Cost: $7,171,095

Estimated Annual O&M: $273,450
Estimated Total Cost: $14,454,670
Estimated Construction Time Frame: 72 months

LNAPL-5 takes a more aggressive approach to the extraction of free phase LNAPL by employing bioslurping technology. Bioslurping is a vacuum extraction process (and is further discussed in the Preferred Alternative section of this plan).

Alternative LNAPL-5: Institutional Controls, Cover and Drainage Improvements, Limited Off-Property Excavation (Gaventa Pond Seep and Green Acres Property), Enhanced LNAPL Recovery (via Bioslurping and Thermal/Steam), and Containment (via Phytoremediation/Alternative Final Cover)

Estimated Capital Cost: $8,524,335
Estimated Annual O&M: 294,333
Estimated Total Cost: $16,524,638
Estimated Construction Time Frame: 72 months

LNAPL-5 is the most aggressive remedial alternative for this media. In addition to bioslurping, thermal technologies would be employed to mobilize the free phase liquids with high viscosities, thereby allowing the bioslurping system to extract them from the ground.

SHALLOW GROUNDWATER

Shallow groundwater (SGW) contamination is primarily impacted by LNAPLs and hot-spot soil contamination. Therefore, integration with the LNAPL alternative is critical to the successful risk reduction and remediation of the site. The bioslurping component of the LNAPL alternatives, in addition to collecting free phase product would also recover an estimated 11 million gallons of shallow groundwater (over the first five years of operation). In that respect, it may be considered a defined-term shallow groundwater pumping system.

Alternative SGW-1: No Further Action, Unmonitored Natural Attenuation

Estimated Capital Cost: $0
Estimated Annual O&M: $0
Estimated Total Cost: $0
Estimated Construction Time Frame: None

Alternative SGW-2: Institutional Controls, Source Remediation/Control (see Soils/LNAPL), and Monitored Natural Attenuation

Estimated Capital Cost: $168,000
Estimated Annual O&M: $88,950
Estimated Total Cost: $1,932,149
Estimated Construction Time Frame: 36 months

Alternative SGW-3: Institutional Controls, Source Remediation/Control (see Soils/LNAPL), In-Situ Treatment (via Phytoremediation), and Monitored Natural Attenuation

Estimated Capital Cost: $1,674,000
Estimated Annual O&M: $121,950
Estimated Total Cost: $4,247,434
Estimated Construction Time Frame: 36 months

DEEP GROUNDWATER

Alternative DGW-1: No Further Action, Unmonitored Natural Attenuation

Estimated Capital Cost: $0
Estimated Annual O&M: $0
Estimated Total Cost: $0
Estimated Construction Time Frame: None

Alternative DGW-2: Source Area In-Situ Treatment (via Chemical Oxidation (ISCO) and Enhanced Aerobic Biodegradation)

Estimated Capital Cost: $14,687,099
Estimated Annual O&M: $166,500
Estimated Total Cost: $20,217,749
Estimated Construction Time Frame: 48 months

Active Alternatives DGW-2, 3, 5 and 6 employ in-situ treatment technologies such as chemical oxidation or enhanced biodegradation, along with groundwater pumping.

Alternative DGW-3: Source Area In-Situ Treatment (via Chemical Oxidation), Monitored Natural Attenuation

Estimated Capital Cost: $9,738,144
Estimated Annual O&M: $111,000
Estimated Total Cost: $13,417,255
Estimated Construction Time Frame: 48 months

Alternative DGW-4: Source Area Containment Pumping/Treatment/Discharge with Downgradient In-Situ Treatment (via Enhanced Aerobic Biodegradation)

Estimated Capital Cost: $11,704,770

Estimated Annual O&M: $2,272,148
Estimated Total Cost: $48,492,384
Estimated Construction Time Frame: 48 months

Alternatives DGW-4 and 5 are containment technologies and will not actively treat groundwater at the site.

Alternative DGW-5: Source Area Containment Pumping/Treatment/Discharge with Downgradient Monitored Natural Attenuation

Estimated Capital Cost: $5,009,445
Estimated Annual O&M: $2,044,724
Estimated Total Cost: $34,284,834
Estimated Construction Time Frame: 48 months

Alternative DGW-6: Phased Combination

Principal Threat Zone (PTZ) Pumping and Treatment (for Mass Reduction), followed by In-Situ Treatment (via Chemical Oxidation) in Significant Rebound Areas, and Enhanced Biodegradation

Lower Threat Zone (LTZ – i.e., area surrounding the PTZ) Pumping and Treatment (for Mass Reduction), followed by Enhanced Biodegradation in Significant Rebound Areas, and Downgradient Area Enhanced Biodegradation

Estimated Capital Cost: $26,986,075
Estimated Annual O&M: $3,709,336
Estimated Total Cost: $57,719,628
Estimated Construction Time Frame: 48 months

Alternatives DGW-6 and 7 employ multiple technologies in different areas of the site. These technologies will be employed following an adaptive or sequenced event management process. In the process, treatment will be applied and potentially re-applied in zones not responding or achieving remedial action objectives.

Alternative DGW-7: Phased Combination Source Area (PTZ) Pumping and Treatment (for Mass Reduction), followed by In-situ Treatment (via Chemical Oxidation) in Significant Rebound Areas, followed by Enhanced Biodegradation in Significant Rebound Areas, and Downgradient Area Monitored Natural Attenuation

Estimated Capital Cost: $20,438,575
Estimated Annual O&M: $3,528,287
Estimated Total Cost: $47,216,495
Estimated Construction Time Frame: 48 months

WETLANDS

Wetland alternatives take into consideration that approximately 10 acres of wetlands pose ecological risks substantially exceeding sediment screening criteria. The wetlands are divided into *De Manifestis* Intermediate (IZ) and *De Minimis* zones. Human health risks are not an issue with regard to the wetlands.

Due to the substantial differences in the potential applicability of the various alternative groupings, separate sets of alternatives were developed and screened for the *De Manifestis* and *Intermediate* zones. A total of five remedial alternatives survived the two-tier screening process for the *De Manifestis* zone. All five were carried forward for detailed analysis.

__Alternatives for De Manifestis Zone Areas:__

Alternative DMZ-1: No Further Action, Unmonitored Natural Remediation

Estimated Capital Cost: $0
Estimated Annual O&M: $0
Estimated Total Cost: $0
Estimated Construction Time Frame: None

Regulations governing the Superfund program expect that a no action alternative be evaluated generally to establish a baseline for comparison. Under this alternative, no additional remedial action beyond that which has already taken place would occur. The BROS property institutional controls will remain in place. Natural remediation processes evidenced in the DMZ areas of the site include deposition of clean sediment, sequestration of metals, and absorption and biological degradation of organics, COPECs and LNAPL.

Alternative DMZ-2: Semi-solid Excavation, Ex-Situ Treatment, On-Site Disposal (Sediment Management Area), Backfill, and Wetland Restoration

Estimated Capital Cost: $8,493,195
Estimated Annual O&M: $30,000
Estimated Total Cost: $10,297,524
Estimated Construction Time Frame: 36 months

This would involve the physical removal of petroleum and PCB-impacted sediment and organic muck by excavation. Excavated material would be solidified and stabilized prior to transport and disposal on-site in a newly constructed sediment management area on the BROS property. The excavated area would be backfilled with clean material to facilitate subsequent wetland restoration.

Alternative DMZ-3: Semi-Solid Excavation, Ex-Situ Treatment, Off-Site Disposal (Landfilling), Backfill, and Wetland Restoration

Estimated Capital Cost: $9,384,228
Estimated Annual O&M: $20,000
Estimated Total Cost: $11,145,429
Estimated Construction Time Frame: 36 months

Alternative DMZ-4: Semi-Solid Excavation, Ex-Situ Treatment, On-Site Disposal (Sediment Management Area), In-Situ Treatment with Sorptive Agent (prior to Capping or incorporated into Backfill), Backfill, and Wetland Restoration

Estimated Capital Cost: $9,121,029
Estimated Annual O&M: $30,000
Estimated Total Cost: $11,019,533
Estimated Construction Time Frame: 36 months

Alternative DMZ-4 is identical to DMZ-2, with the exception that a sorptive agent would be applied over the exposed excavated surface of the DMZ.

Alternative DMZ-5: Semi-Solid Excavation, Ex-Situ Treatment, Off-Site Disposal (Landfilling), In-Situ Treatment with Sorptive Agent (prior to Capping or incorporated into Backfill), Backfill, and Wetland Restoration

Estimated Capital Cost: $10,012,062
Estimated Annual O&M: $20,000
Estimated Total Cost: $11,867,438
Estimated Construction Time Frame: 36 months

__Alternatives for Intermediate Zone areas:__

IZ-1 No Further Action, Unmonitored Natural Remediation

No additional remedial action beyond that which has already been conducted.

Estimated Capital Cost: $0
Estimated Annual O&M: $0
Estimated Total Cost: $0
Estimated Construction Time Frame: None

IZ-2: Natural Remediation (Monitored), Institutional Controls

Monitoring and institutional controls beyond those already implemented at the site. Monitoring would be performed to confirm the stability of existing conditions following DMZ remediation.

Estimated Capital Cost: $ 0
Estimated Annual O&M: $65,000
Estimated Total Cost: $577,232
Estimated Construction Time Frame: None

IZ-3: Silt/Clay Cover, and Wetland Restoration

This alternative involves the placement of a silt/clay cover over the entire IZ area to minimize the potential for direct contact between the IZ sediment and potential ecological receptors.

Estimated Capital Cost: $975,238
Estimated Annual O&M: $45,000
Estimated Total Cost: $1,633,059
Estimated Construction Time Frame: 12 months

IZ-4: Silt/Clay Cover with Sorptive Agent Properties (In-Situ Treatment), and Wetland Restoration

This alternative is similar to IZ-3 but adds a sorptive agent prior to, during, or immediately after placement to further reduce the potential movement of COPECs.

Estimated Capital Cost: $1,439,613
Estimated Annual O&M: $45,000
Estimated Total Cost: $2,197,090
Estimated Construction Time Frame: 12 months

EVALUATION OF ALTERNATIVES

The complexity of site conditions and varied contaminants of concern (including VOCs, SVOCs, PCBs and lead) had a significant impact on the number of viable and appropriate alternatives for addressing the remaining conditions at the site. Site complexities include the non-homogenous nature of shallow subsurface materials (i.e., debris commingled with the soil in many areas), widespread LNAPL above, at and below the water table, high PCB concentrations in the LNAPL, and the widespread distribution of contamination both surrounding and beneath the remediated former lagoon area.

The interaction of contaminant movement between the various media further complicates the selection of technologies for the site. To address this issue, an integrated, sequentially conducted or adaptive remedial action approach was considered and forms the basis for the preferred alternative. Additional information on sequencing of remedial actions is provided in the Preferred Alternative section.

The nine criteria identified in the NCP are used to evaluate the alternatives and compare them to one another in the detailed analysis of the FS. These include threshold criteria (Overall Protection of Human Health and the Environment/Compliance with ARARs), which are requirements each alternative must meet in order to be eligible for consideration, primary balancing criteria (Long-Term Effectiveness/ Reduction in Toxicity, Mobility or Volume Through Treatment/Short-Term Effectiveness/Implementability /Cost), which are used to weigh some of the major trade-offs among the alternatives and modifying criteria (State Acceptance/Community Acceptance), which incorporate state/support agency and community feedback. An overview of how the alternatives meet all of the criteria, focusing on the preferred alternative follows. The RI/FS report contains more detailed information on the alternatives analysis including the alternatives considered but not recommended for action at the site.

Overall Protection of Human Health and the Environment

While surficial soils at the site are clean and do not pose a significant threat to human health or the environment, a number of future use scenarios exhibit potentially completed exposure pathways. Remedial measures found in all of the alternatives, with the exception of the no action alternative, contain ICs and drainage improvements to reduce the impacts from contaminated soil. As these processes are also amenable to the more significant LNAPL media, they are not discussed under the soil category. The preferred soil alternative, SHS-4, does contain an enhanced biodegradation component which will provide a higher level of treatment among the alternatives.

Alternative LNAPL-5 provides the highest level of protection depending on bioslurping technology performance. LNAPL-5 was selected over the other active remediation alternatives based on its ability, through the addition of thermal technologies (in addition to bioslurping technology), to remove and treat the various types and viscosities of oily LNAPL present in different areas of the site.

Shallow groundwater will be managed primarily through the implementation of the soil and LNAPL alternatives.

Deep groundwater alternatives are centered on the ability to achieve established restoration goals and the time frame required for implementation. Alternatives DGW-2, 3, 6 and 7 provide direct aquifer treatment, while DGW-4 and 5 involve primarily hydraulic control technologies. Alternatives DGW-6 and 7 provide the greatest protection and employ phased, combined technologies to address both the PTZ and LTZ.

Compliance with ARARs

Actions taken at any Superfund site must meet all applicable or relevant and appropriate requirements of federal and state law or provide grounds for invoking a waiver of those requirements. The preferred remedy is believed to provide the best opportunity to achieve ARARs.

For soils, Alternative SHS-4 will provide the highest level of treatment and thus the shortest remediation time. Given the potential difficulty in achieving soil ARARs in the subsurface on-property, the enhanced biodegradation component was deemed necessary.

There is some concern that the biodegradation component of the preferred alternative will interfere with the bioslurping component of the preferred LNAPL alternative. This concern will be further evaluated during the field work stage. Should the biodegradation component be determined to be detrimental to the success of bioslurping, it may not be implemented or may be considered in the future.

The State of New Jersey requires the removal of LNAPLs to the extent practicable. Alternatives LNAPL-2 and 3, using passive techniques similar to the ones currently operating on-site may not satisfy this requirement. LNAPL-5 provides the highest level of compliance.

Implicit in SGW-2 is that the soil and LNAPL components will be implemented as part of the overall site-wide remedy.

Alternatives DGW-6 and 7 will achieve ARARs for the PTZ, while DGW-3 and 4 can only do so if an alternate compliance point is established.

Long-Term Effectiveness and Permanence

Alternative SHS-4 provides the highest degree of long-term effectiveness.

Both LNAPL-4 and 5 provide high levels of recovery and treatment affording long-term effectiveness and permanence. More highly viscous fluids may only be removed through LNAPL-5.

SGW-2 will add additional monitored natural attenuation and monitoring to the soil and LNAPL components.

Alternatives DGW-6 and 7 afford the highest degree of long-term effectiveness and permanence.

Reductions in Toxicity, Mobility and/or Volume through Treatment

Alternative SHS-4 provides the highest level of treatment to reduce toxicity, mobility and volume of COCs.

LNAPL-4 and 5 provide the highest level of treatment to reduce toxicity, mobility and volume. LNAPL-5 may be required to mobilize more viscous fluids present on the site, thereby allowing a larger volume of LNAPL to be removed.

As part of the overall site-wide remedy, millions of gallons of shallow groundwater will be extracted. While attaining water quality standards on-property is recognized as difficult and perhaps impracticable, the overall approach to shallow groundwater remediation, including the implementation of SGW-2, will provide the most reduction in toxicity, mobility and volume of all the alternatives evaluated.

DGW-6 and 7 offer the highest level of treatment to reduce the toxicity, mobility and volume of COCs at the site. DGW-6 is believed to offer the highest potential to reduce the time frame required to achieve site RAOs.

Short-Term Effectiveness

For soils, none of the alternatives are projected to pose any unacceptable risk to the community, workers or the environment, although there are some risks associated with construction and implementation activities for all the alternatives except no action.

While none of the active alternatives are projected to pose any unacceptable risk to the community, workers or the environment, LNAPL-5, by using thermal enhancements, does pose some risk of cross-contamination to non-impacted soils.

There are no unacceptable risks associated with SGW-2.

None of the alternatives are predicted to pose unacceptable risks to the community, workers, or the environment during construction or implementation.

Implementability

Soil alternative implementation risks are low. Some field trials may be necessary.

Field trials will be required for all the active LNAPL alternatives. Work completed to date by EPA, including the LNAPL extraction program and water budget testing using phyto-technology (planting trees to reduce the amount of water available to infiltrate the site) will assist in future system design. LNAPL-5 will require the most field-scale pilot work due to the potential use of thermal enhancement technology in addition to bioslurping. Performance criteria will be established to determine the need for the thermal enhancement component of the preferred alternative.

Shallow groundwater adds a monitored natural attenuation component to soil and LNAPL technologies and is fully implementable.

The technical feasibility of deep groundwater chemical oxidation and enhanced aerobic biodegradation has been demonstrated through treatability studies. DGW-6 will require some field-scale pilot testing to finalize design parameters and there are some additional administrative issues regarding the underground injection of treatment chemicals and surface water discharge from a planned on-site treatment plant. However, the overall potential for a successful remedial action in a timely manner makes it the preferred alternative. Further, the preferred alternative includes a contingency action consisting of hydraulic containment (DGW-4).

Cost

Total remedy costs, unadjusted for present value, will be used for remedial alternative comparison purposes in this Proposed Plan. Present worth costs are generally less than total costs.

The estimated costs for implementation of the biodegradation component for soils are reasonable and may be reduced pending the outcome of aggressive LNAPL remediation.

Although Alternative LNAPL-5 comes at the highest cost, it will provide for the greatest contamination mass reduction.

Most of the costs related to shallow groundwater remediation are contained in the soil and LNAPL alternatives. Costs for the added SGW-2 monitored natural attenuation and monitoring component are reasonable.

While DGW-6 is at the upper end of costs for deep groundwater remediation, the alternative provides the most opportunity for a successful deep groundwater cleanup in a timely manner.

EPA also analyzed the feasibility of excavation alternatives for remediation of the contaminated soil. Targeted and aggressive excavation approaches have high estimated costs at $34.6 million and $126 million, respectively. These alternatives were not considered further due to the potential for recontamination of remediated areas from the remaining LNAPL and the extent of residual contamination which would not be practicable to remove.

PREFERRED ALTERNATIVE

For *Soil, LNAPL and Shallow Groundwater,* Alternatives SHS-4, LNAPL-5 and SGW-2 are preferred. For *Deep Groundwater,* Alternative DGW-6 is preferred with DGW-4 as a contingency. For *Wetlands,* Alternatives DMZ-5 and IZ-2 comprise the preferred approach. Table 2 provides EPA's recommended remedy components by media.

EPA recommends, and is putting forth as the preferred remedy a combination of Alternative SHS-4 for soils, LNAPL-5 for LNAPLs, SGW-2 for shallow groundwater, and DGW-6 for deep groundwater. The Agency prefers Alternative DGW-6 (vs DGW-7) for deep groundwater because it more actively addresses (via in-situ biological treatment) a portion of the downgradient groundwater contaminant plume. In addition, Alternative DGW-4 (hydraulic containment) is presented as a contingency remedy, to be implemented if the planned methods to treat the LNAPLs and deep groundwater do not prove to be sufficiently effective.

The preferred remedy includes cover and drainage improvements, bioslurping, and water budget management/phytoremediation to reduce contaminant levels in soil, LNAPL and shallow groundwater. The drainage improvements will include site regrading and placement of engineered drainage channels where necessary. Limited off-property excavation will also help manage soil, LNAPL and shallow groundwater contamination for Gaventa Pond and the Green Acres property area.

Bioslurping will be the primary technology to attack the multi-media contamination on-property. Bioslurping involves the vacuum extraction of LNAPL through a slurp tube set at the LNAPL/groundwater interface. Adjustments to the tube are made to optimize the withdrawal of free phase materials. During this process, shallow groundwater and or vapors/soil gas (in the unsaturated zone) will be withdrawn when the level of LNAPL drops or raises based on pumping and/or water table elevation conditions (when the vacuum extraction tube is not centered in the free phase LNAPL, but in the unsaturated zone or beneath the free phase LNAPL in the shallow groundwater).

Enhancements to bioslurping, which utilize thermal technologies will be implemented on an as-needed basis. Based on a focused feasibility study, steam injection is the technology most likely to be employed at the site. An alternate final cover will be placed in select areas and select institutional controls will also be utilized.

Deep groundwater remediation will employ pumping and treatment for mass reduction, followed by in-situ chemical oxidation. Additional aquifer pumping and chemical oxidation treatment will be performed, where necessary, following the adaptive management process (conducting additional treatment events in areas where contaminant concentrations rebound). In the principal threat zone, enhanced biodegradation will be employed following the chemical oxidation. Source area containment pumping with enhanced biodegradation in downgradient areas is proposed as the contingency remedy should chemical oxidation prove ineffective.

The primary treatment technology, chemical oxidation, uses chemicals called oxidants to destroy pollution in groundwater. Oxidants help change harmful chemicals into harmless ones, like water and carbon dioxide. To clean up the site faster, aquifer pumping is proposed along with oxidant injection. This approach helps mix the oxidant with the harmful chemicals in the groundwater. A range of oxidants will be tested at the site including hydrogen peroxide and potassium permanganate. Biological treatment (the biodegradation component for shallow groundwater) will include the addition of nutrients and/or an oxygen source.

The wetlands remediation will include excavation of sediment with ex-situ treatment and off-site disposal. Sorptive agents will also be added and the disrupted areas of wetland will be restored. Excavation is a proven technology.

The estimated costs to implement the alternatives that comprise the preferred remedy include:

Groundwater Work	
Soil/LNAPL/Shallow Groundwater	$20.7 million
Deep Groundwater	$57.7 million
(Groundwater Contingency)	($42.5 million)
Wetlands Work	
DMZ/IZ	$12.5 million
Total Estimated Cost (without groundwater contingency)	$90.9 million

Although present worth costs have not yet been calculated, EPA very roughly estimates those costs to be less than $80 million (without the groundwater contingency). Excluding the wetlands work, those costs are estimated at under $70 million.

EPA believes it is appropriate to include a containment contingency involving a more conventional technology given the innovative nature of the various technologies to be employed to treat the soils, LNAPLs and groundwater contamination associated with the BROS site. A plan to determine the criteria that trigger the need to implement the contingency remedy would need to be developed. However, since the groundwater extraction and treatment facilities constructed for the preferred alternative (and also used for the contingency remedy) will already be in place, only limited construction of additional groundwater recovery wells would be anticipated.

In addition, the Agency believes some efforts should be made to reduce contaminant levels in the groundwater plume emanating from the site. Treatability studies indicate that contaminants in the plume can be effectively treated by in-situ biological methods. Although EPA does not yet have detailed information to quantify the benefits of enhanced biodegradation for the downgradient portion of the plume, the Agency believes this to be an appropriate component of the groundwater remedy. It will reduce the elevated concentrations of VOCs in downgradient groundwater in a shorter period of time, which is desirable given the development pressures in the area and the reliance on groundwater resources for potable water supplies. It further provides these benefits at a reasonable cost.

It should also be recognized that the adaptive management approach being recommended for remediation of the BROS site could realize additional cost savings. A key benefit of this flexible approach is that it allows specific actions to be evaluated and adjustments made to sequential actions. There is a potential that some of the innovative technologies may work better or be more effective than expected reducing the need for, or extent of, subsequent remedial actions. For example, the chemical oxidation process for the treatment of source area groundwater contamination (i.e., Alternative DGW-6/7) could be so effective that enhanced biodegradation is not necessary for the downgradient groundwater plume. Of course, the reverse outcome is also a possibility. The ultimate goal of the recommended approach is to achieve the maximum benefit at a reasonable cost. The site decision documents will recognize that the adaptive management remedial strategy may result in some variation of the components of the selected remedy during implementation.

While the final sequencing of events will be determined during the design phase of project activities, the following order of major tasks is currently proposed.

1. Site preparation/ design/ contracting/ permitting
2. Limited west side property and off-property LNAPL management
3. Cover and drainage improvements
4. Wetlands excavation
5. Bioslurping/ LNAPL recovery/ shallow groundwater (five years)
6. Cover and drainage improvements
7. Initial pumping of deep groundwater (one year)
8. Chemical treatment of groundwater (multiple events)
9. Biological treatment of groundwater (multiple events)
10. Water budget management
11. Final restoration/ alternate cover placement

Based on information currently available, EPA believes that the Preferred Alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. EPA expects the Preferred Alternative to satisfy the following statutory requirements of CERCLA Section 121 (b): (1) be protective of human health and the environment; (2) comply with ARARs (or provide future justification for a waiver or technical impracticability assessment); (3) be cost effective; (4) utilize permanent solutions and alternative treatment technologies to the maximum extent practical; and (5) satisfy the preference for treatment as a principal element.

NATIONAL REMEDY REVIEW BOARD

The site was evaluated by EPA's National Remedy Review Board (NRRB). The board functions as an internal peer review group and includes senior Agency staff with a broad range of technical expertise across the country. It was established to review complex remedies to ensure they are both cost effective and nationally consistent. The board's comments and the Region's responses are included in the Administrative Record file. In general, the NRRB agreed with the Region's preferred approach for the site.

COMMUNITY PARTICIPATION

EPA relies on public input to ensure that the concerns of the community are considered in selecting an effective remedy for each Superfund site. To this end, the Proposed Plan, Remedial Investigation report, Feasibility Study report and other documents are being made available to the public for a 30-day comment period which begins on July 12 and concludes on August 11, 2006. The Proposed Plan and other documents have been placed, and are available at the following repositories:

Township of Logan Municipal Building
125 Main Street, Bridgeport, New Jersey 08014
(Business Hours: 8:00 a.m. to 4:00 p.m., M-Th
8:00 a.m. to 1:00 p.m., Fri.)

or

Superfund Docket Room
U.S. EPA Docket Room, Region 2
290 Broadway, 18th Floor
New York, New York 10007-1866
(Business Hours: 9 a.m. to 5 p.m., M-F)

Contact the Remedial Project Manager for access (Telephone - 212-637-4375).

A public meeting will be held during the public comment period at the Logan Township Municipal Building on July 25, 2006 at 7:00 P.M. to present the conclusions of the RI/FS, to elaborate further on the reasons for recommending the preferred alternative, and to receive public comments. Written comments on the Proposed Plan or the RI/FS report will also be welcomed through August 11, 2006. All written comments should be addressed to:

Ronald Naman, Remedial Project Manager
U.S. Environmental Protection Agency Region 2
290 Broadway, 19th Floor
New York, New York 10007-1866
Telephone: (212) 637- 4375/
Fax: (212) 637- 4429
E-mail: Naman.RonaldM@epamail.epa.gov

Although the Proposed Plan identifies the preferred remedy, a final decision will be made only after consideration of all comments received within the comment period. Changes to the preferred remedy may be made if public comments or additional data indicate that such a change will result in a more appropriate remedial action. Comments received at the public meeting, as well as written comments, will be documented in the Responsiveness Section of the Record of Decision, the document which formalizes the remedy selection.

Table 1: Chemicals of Concern – Breakout of Chemical Classes

COCs / MEDIA	VOCs (1)				SVOCs (2)	PCBs (3)	Metals	Low pH (4)	Total Petroleum Hydrocarbons
Soils/LNAPL/Shallow Groundwater/Deep Groundwater									
	BTEX (5)	TCE (6)	DCE (7)	VC (8)	BCEE		Fe/Mn (9)		
Soils		X	X	X	X (localized)				
LNAPL	X	X				X			
Shallow Groundwater	X	X	X	X	X		X	X (localized)	
Deep Groundwater	X	X	X	X	X		X	X	
Wetlands									
Sediments						X	X (10)		X
Surface Water						X (11)	X (12)		

(1) Includes volatile organic compounds such as benzene, toluene, ethylbenzene, xylene, trichloroethene, dichlorethene and vinyl chloride for all media with the exception of LNAPL where only benzene, toluene, ethylbenzene, xylene and trichloroethene present the greatest concern.
(2) Semi-volatile organic compounds (primarily bis (2-chloroethyl) ether (BCEE))
(3) Polychlorinated biphenyls
(4) Residual sulfuric acid waste
(5) Benzene, toluene, ethylbenzene and xylenes
(6) Trichloroethene
(7) Dichloroethene
(8) Vinyl chloride
(9) Predominantly iron and manganese
(10) Predominantly lead
(11) Some detections in both filtered and non-filtered samples
(12) Not detected in filtered samples

TABLE 2
BROS Preferred Remedy Components by Media

Media	Alternative No.	Remedy Components	Estimated Costs
Wetlands	DMZ-5	Excavation/ Ex-Situ Treatment/ Off-Site Disposal/ Application of Sorptive Agent (prior to Capping or incorporated into Backfill)/ Wetlands Restoration Physical Amenities: Includes the excavation of approximately 17,500 cubic yards of contaminated sediment and application of sorptive material over 10.6 acres.	$11.9M
	IZ-2	Natural Remediation (Monitored)/ Institutional Controls	$0.6M
Soil, LNAPL, and Shallow Groundwater	SHS-4	Enhanced Biodegradation Component Only Physical Amenities: Includes the installation of at least 230 chemical injection points.	$2.3M
	LNAPL-5	Institutional Controls/ Cover and Drainage Improvements/ Limited Off-Property Excavation (Gaventa Pond Seep and Green Acres Area)/ Enhanced LNAPL Recovery via Bioslurping and Thermal/Steam Injection (where warranted following Bioslurping)/ Containment-Water Budget Management via Phytoremediation/Alternate Final Cover Physical Amenities: Includes the installation of approximately 72 bioslurping extraction points. Water budget management may include planting up to 1,000 trees per acre in LNAPL areas.	$16.5M
	SGW-2	Institutional Controls/ Source Remediation/Control/ Monitored Natural Attenuation	$1.9
Deep Groundwater	DGW-6	**Phased Combination:** <u>Source Area (Principal Threat Zone)</u> Pumping and Treatment (Mass Reduction)/ Followed by In-Situ Chemical Oxidation Treatment in Significant Rebound Areas/ Followed by Enhanced Biodegradation -- <u>Lower Threat Zone</u> Pumping and Treatment (Mass Reduction)/ Followed by Enhanced Biodegradation in Significant Rebound Areas <u>Downgradient Area</u> Enhanced Biodegradation Physical Amenities: Includes the installation of over 50 extraction wells in the PTZ/LTZ and 300 Chemical Oxidant injection wells. Will include the inoculation of groundwater with an estimated 600,000 pounds of oxidant and the extraction of over 100 million gallons of contaminated groundwater over the first two years of operation. Long-term operations could realize the extraction of over 500 million gallons of groundwater.	$57.7M
Deep Groundwater Contingency	DGW-4	Source Area Containment Pumping and Treatment/ Downgradient Area Enhanced Aerobic Biodegradation Physical Amenities: Includes the groundwater treatment plant constructed for DGW-6 with additional wells to capture the plume.	$48.5M (1) (1) If implemented as a contingency, cost would be reduced by capital expenditure for treatment plant construction under DGW-6 - estimated at $6 million.

Estimated total cost: $90.9M (Wetlands $12.5M; Soils, LNAPLs, Shallow GW $20.7; Deep GW $57.7M)

10.00030

Figure 1 – Site Location Map

Based on COCs in Soil, LNAPL, Groundwater and Wetlands

LEGEND

	BROS SITE (BASED ON WETLANDS AND OPEN WATER AREAS)
	APPROXIMATE BROS SITE BOUNDARY BASED ON GROUND WATER DATA, AS PRESENTED IN THE UPDATED (2002) WELL RESTRICTION AREA AT THE BASE (BOTTOM 15 FEET) OF THE UPPER MIDDLE PRM AQUIFER.
	APPROXIMATE BROS PROPERTY BOUNDARY
	BOUNDARY OF UPDATED WELL RESTRICTION AREA FOR RECENT STRATA AND A PORTION OF THE UPPER PRM AQUIFER
LTCS	LITTLE TIMBER CREEK SWAMP
CS	CEDAR SWAMP

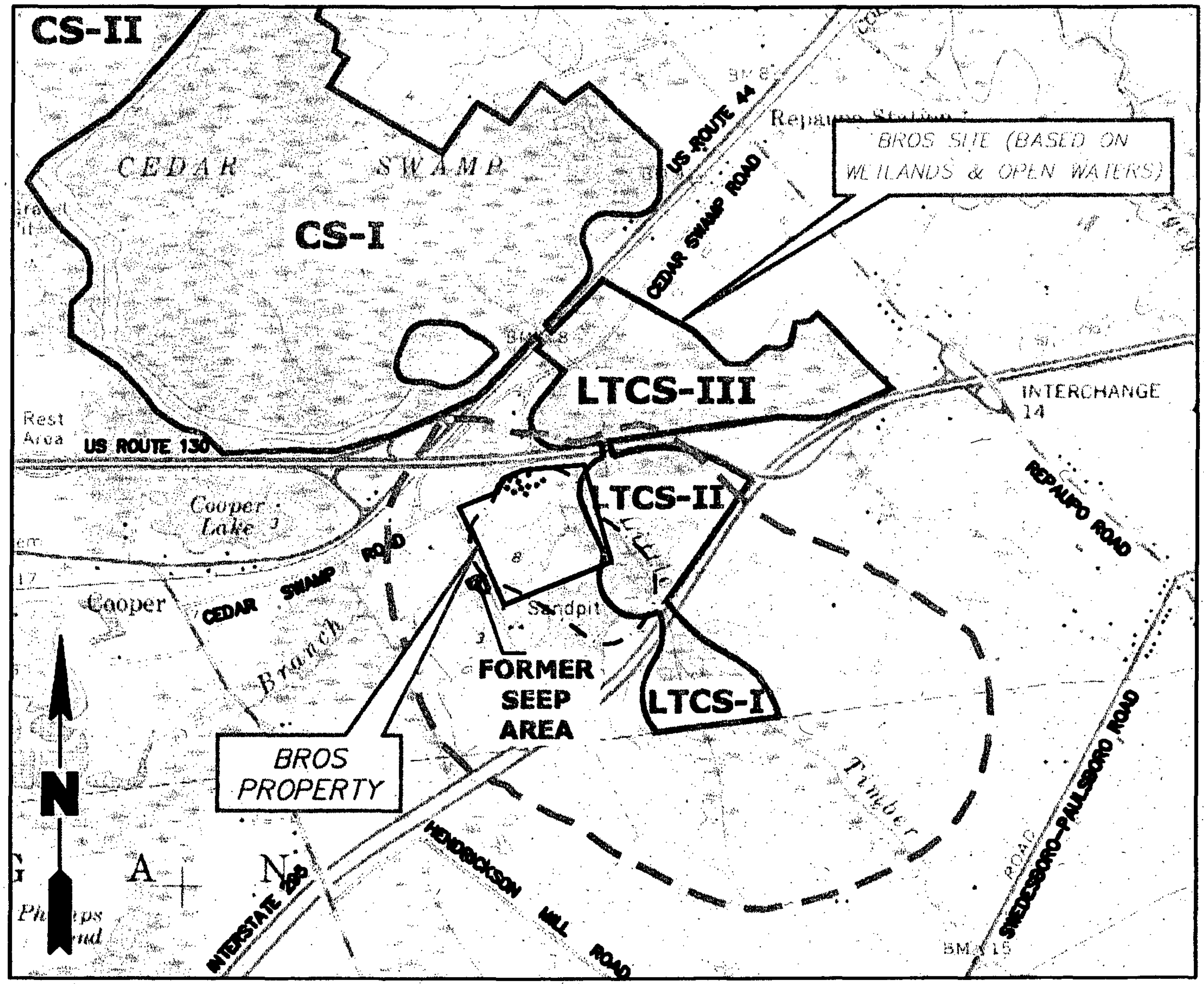

Figure 2 – Site Map

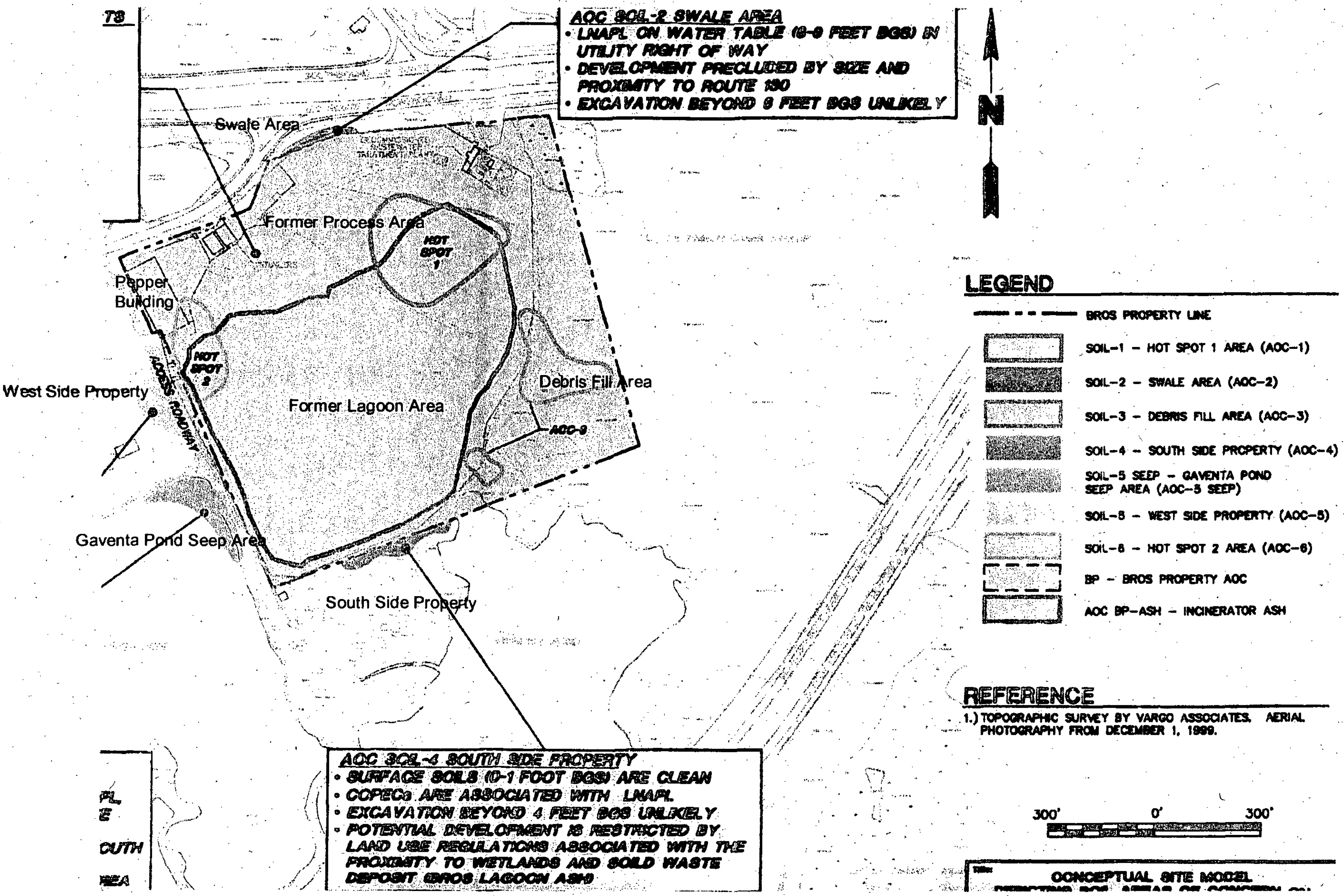

Figure 3 – Distribution of Shallow Groundwater Contamination (Based on VOCs)

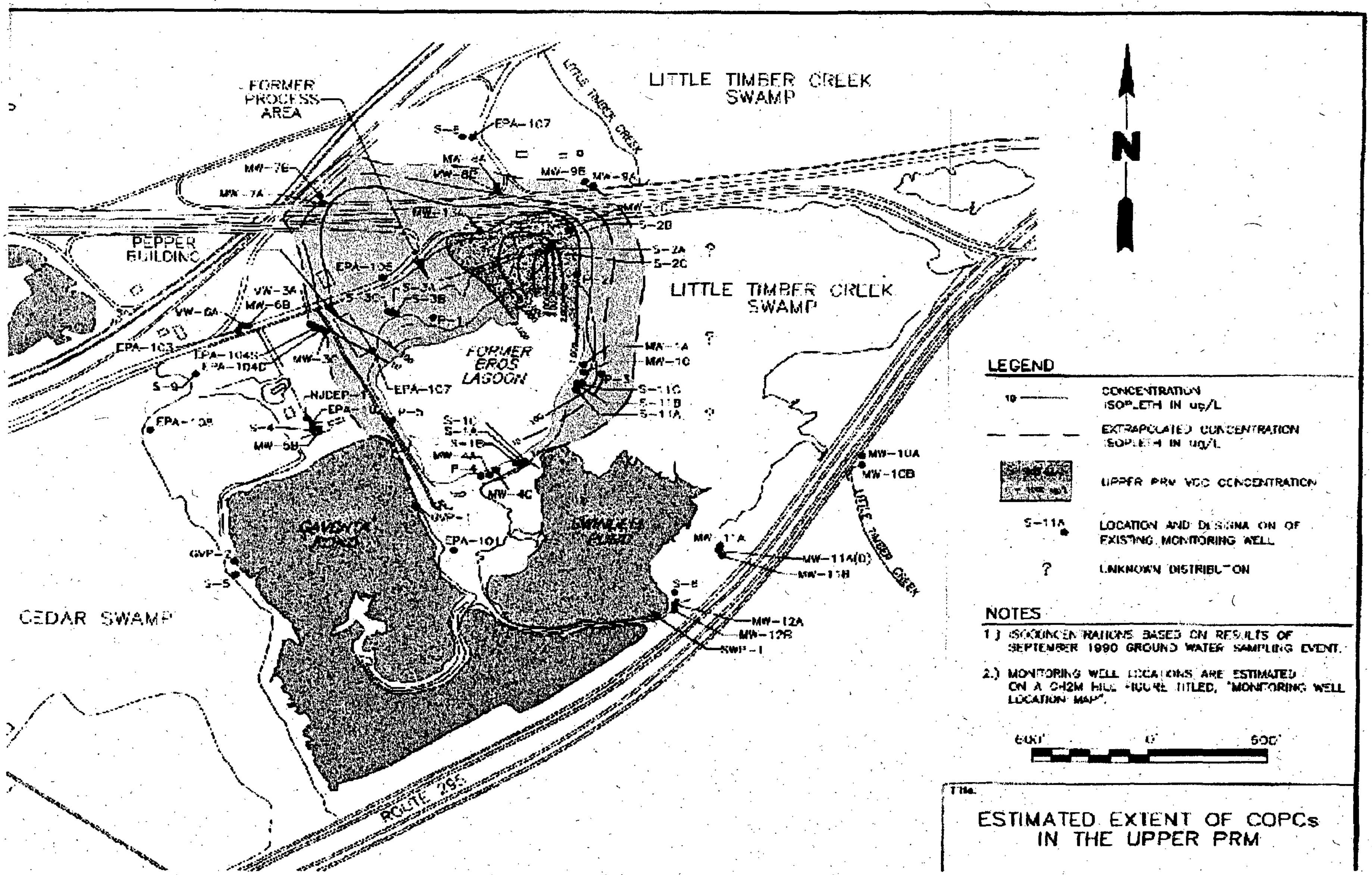

Figure 4 – Distribution of Deep Groundwater Contamination
(Based on Benzene and TCE)

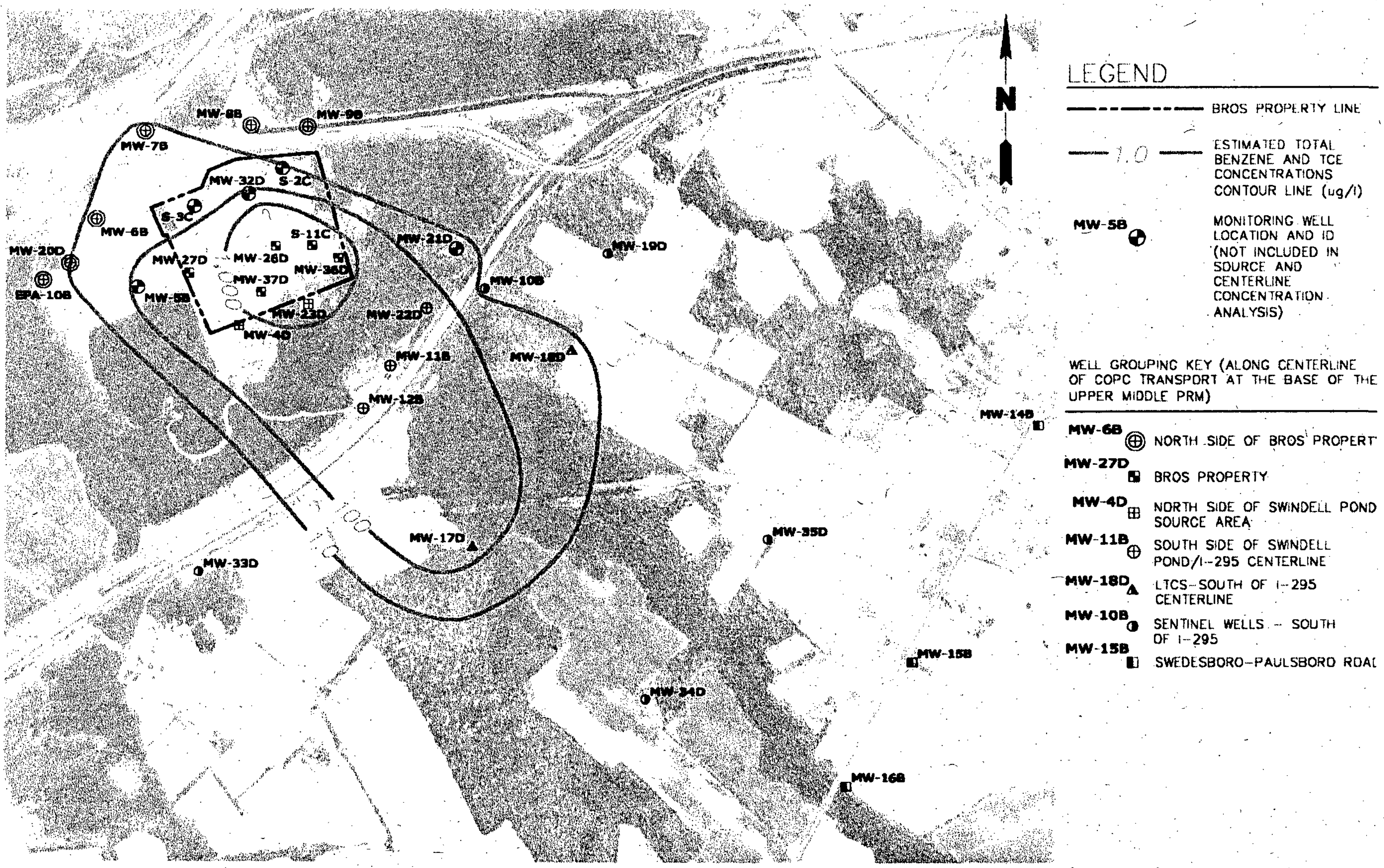

Figure 5 – Geographic Distribution of Wetland Risk Zones